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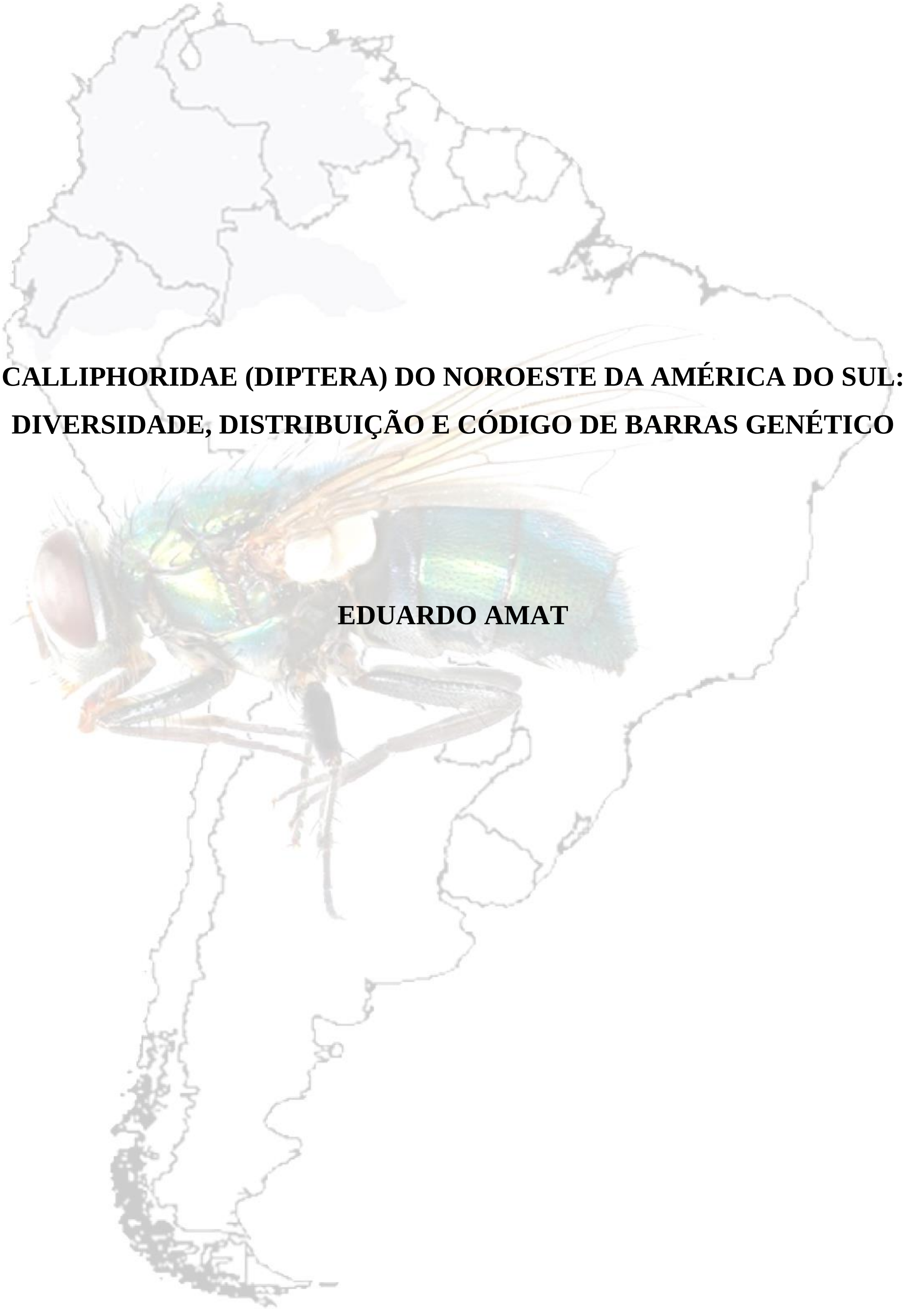

CALLIPHORIDAE (DIPTERA) DO NOROESTE DA AMÉRICA DO SUL: DIVERSIDADE, DISTRIBUIÇÃO E CÓDIGO DE BARRAS GENÉTICO

EDUARDO AMAT

Manaus, Amazonas
Dezembro, 2017

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CALLIPHORIDAE (DIPTERA) DO NOROESTE DA AMÉRICA DO SUL: DIVERSIDADE, DISTRIBUIÇÃO E CÓDIGO DE BARRAS GENÉTICO

ORIENTADOR: **JOSE ALBERTINO RAFAEL**

Tese apresentada ao Instituto Nacional de Pesquisas da Amazônia como parte dos requisitos para obtenção do título de Doutor em Entomologia.

Manaus, Amazonas
Dezembro, 2017

Eduardo Amat

Titulo

Calliphoridae (Diptera) do noroeste da América do Sul: Diversidade, distribuição e código de barras genético.

Banca julgadora:

Dra. Rosaly Ale Rocha (INPA)

Dr. Rafael Augusto Pinheiro de Freitas Lima (INPA)

Dr. Marcio Luís Leitao Barbosa (INPA)

Dra. Valéria Araújo Braule Pinto (INPA)

Dr. Ronildo Baitone Alencar (UEA)

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BRASIL

ATA DE DEFESA PRESENCIAL PÚBLICA
DOUTORADO

Aos **quinze dias** do mês de **Dezembro** do ano de **2017**, **às 8h30**, no Auditório do PPG/ENT – Campus II do INPA, reuniu-se a Banca Julgadora de Defesa Presencial Pública, composta pelos seguintes Professores Doutores: Rosaly Ale Rocha (INPA); Rafael Augusto Pinheiro de Freitas Silva (INPA); Márcio Luís Leitão Barbosa (INPA); Valéria Araújo Braule Pinto (INPA) e Ronildo Baiatone Alencar (UEA), a fim de proceder à argüição pública da **TESE** do aluno **Eduardo Carlo Amat,** intitulada: "CALLIPHORIDAE (DIPTERA) DO NOROESTE DA AMÉRICA DO SUL: DIVERSIDADE, DISTRIBUIÇÃO E CÓDIGO DE BARRAS GENÉTICO", cujo trabalho foi conduzido sob a orientação do Dr. José Albertino Rafael (INPA).

Após a exposição, o discente foi argüido oralmente pelos membros da Banca Julgadora, tendo recebido o conceito final:

EXAMINADORES	**PARECER**		**ASSINATURA**
Rosaly Ale Rocha	(X) Aprovado	( ) Reprovado	Rosaly Ale Rocha
Rafael Augusto P. de F. Silva	(X) Aprovado	( ) Reprovado	
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Nada mais havendo, foi lavrada a presente ata, que, após lida e aprovada, foi assinada pelos membros da Banca Julgadora.

Rosaly Ale Rocha
Rosaly Ale Rocha
Coord. da Divisão do Curso de PG em
Entomologia - DIENT/INPA
(Em exercício)

INPA-DIENT – Av. André Araújo, 2936, Petrópolis
CEP: 69060-001, Manaus-AM, Brasil.
Fone: (+55) 92 3643-3240/3643-3255
E-mail: cursoent@inpa.gov.br; http://pg.inpa.gov.br/ent

Sinopse

Estudou-se a fauna de Calliphoridae (Diptera) na região noroeste da América do Sul, abordando três aspectos principais: 1. Diversidade local das assembleias; 2. Padrões de distribuição espacial das espécies; 3. Performance do DNA-barcode na identificação das espécies.

Dedico esta conquista com todo o carinho a minha querida família; Blanquita, Domingo, German e Zoila. Vocês são a minha inspiração.

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Obrigado meu Deus por tudo! .... Por estar sempre ao meu lado!!!

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RESUMO

Estudou-se a fauna de Calliphoridae (Diptera) na região noroeste da América do Sul, abordando três aspectos principais: 1. Diversidade local das assembleias; 2. Distribuição geográfica das espécies; e 3. Uso de sequências de DNA na identificação genética das espécies. Para estudar os padrões de diversidade local e avaliar os padrões de riqueza, abundância e dominância foram escolhidos três cenários: o interflúvio amazônico, o gradiente altitudinal nos Andes Colombianos e o ecossistema de Páramo andino. Além disso, foi compilada a informação geográfica de 13.474 espécimes de 28 espécies, depositados em onze coleções entomológicas localizadas no Brasil, Colômbia, Equador e Venezuela. Com base nessa informação foi possível dividir a área de estudo em seis regiões naturais: Amazônia, Andes, Caribe, Orinoquia, Pacífica e Tepuiana. Também foi possível identificar padrões preliminares de distribuição espacial e classificar a fauna de califorídeos segundo a origem biogeográfica: espécies tropicais (25 spp.) temperadas (4 spp.) e introduzidas (4 spp.); segundo a distribuição altitudinal: espécies de terras baixas (17 spp.), espécies de montanha (27 spp.) e espécies de altas elevações (8 spp.) e segundo o grau de sinantropia em espécies assinantrópicas (14 spp.), hemissiantrópicas (13 spp.) e sinantrópicas (14 spp.). Finalmente, foram fornecidas as sequências curtas de DNA mitocondrial com 317 pares de bases (mini-barcode) para trinta espécies, possibilitando a identificação molecular das de *Calliphora*, *Chrysomya*, *Cochliomyia*, *Compsomyiops*, *Sarconesia* e *Hemilucilia*. Contudo, o marcador escolhido não foi adequado para identificar as espécies de *Lucilia*. Além disso, foram recuperadas as sequências genéticas de exemplares antigos depositados em coleções por até 57 anos. Os padrões de diversidade global e os encontrados em cada assembleia avaliada demostraram que a existência de um gradiente altitudinal afeta a composição da fauna de Califorídeos. Foi demostrado que as elevações intermediarias andinas são as mais ricas em espécies e que os Paramos andinos são pobres em califorídeos. A evidente sensibilidade dos Calliphoridae aos ambientes antropogênicos, seu número baixo de espécies e sua taxonomia relativamente estável faz deste um grupo ideal para utilização como indicador de ambientes antropisádos na região norte da América do Sul.

The Blow flies (Diptera: Calliphoridae) of Northwest South America: Diversity, geographical distribution and DNA barcoding.

Abstract

The blow fly fauna of Northwest South America was studied based in three main approaches: 1. Local diversity of assemblages; 2. geographical distribution of their species; and 3. efficacy of short DNA sequences (Mini barcode) to identify their species. In order to study the patterns of species richness, abundance and dominance of local assemblages, three scenarios were chosen: the Amazonian interfluvial region; an altitudinal gradient in the Andean belt and the Páramo ecosystem. By the other hand, the geographical information of 13.474 specimens belonging to 28 species, deposited in eleven entomological collection of Brazil, Colombia, Ecuador and Venezuela was retrieved. Based on this data, it was possible to make a preliminary regionalization into six natural divisions: Amazon, Andes, Caribbean, Orinoquia, Pacific and Tepuyan region. It was also possible to identify preliminary patterns of geographical distribution and classify the blow fly species according to the biographic origin as follow: Tropical (25 spp); Temperate (4 spp) and Introduced (4spp). According to the altitudinal distribution, 17 species come from lowlands; 27 of montane and 8 of high elevations. Finally according to the level of synanthropy: 14 species were asynanthropic; 13 hemisynanthropic and 14 eusynanthropic. We recovered short mitochondrial DNA sequences (Mini barcodes of 317bp) from 143 specimens of thirty Neotropical species. This molecular marker allow the species identification of *Calliphora, Chrysomya, Cochliomyia, Compsomyiops, Sarconesia,* and *Hemilucilia*. However, it was not suitable for the correct identification of *Lucilia* species. In addition, we recovered genetic information from old preserved specimens deposited in museums for up to 57 year. The global diversity patterns together with the local assemblages assessed demostrated that the existence of an altitudinal gradient affects the composition of the blow fly fauna in the region. Being the most diverse assemblages, those located at intermediate elevations and the less diverse the perennial páramo ecosystem. The noticeable sensibility of blow flies to anthropized environments, the relative low number of species and their ubiquity, together with their relatively stable taxonomy, makes this group of flies as an ideal indicator of the level of human influence in environments of Northwest South America.

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INTRODUÇÃO GERAL

Classificação, identificação e diversidade

Calliphoridae (Diptera: Oestroidea) é um grupo de moscas caliptradas, conhecidas comumente no Brasil como califorídeos ou varejeiras, distribuídas por todas as regiões biogeográficas (Marshall 2012). Atualmente a família possui aproximadamente 1.500 espécies (Pape *et al.* 2011), das quais cerca de 60 espécies ocorrem na região Neotropical, exetuados os mesembrinelídeos (Kosmann *et al.* 2013). Entretanto, este número é significativamente menor comparado a riqueza de espécies registradas para o hemisfério oriental (Shewell 1987).

A filogenia de Calliphoridae ainda é um assunto controverso. Os dados morfológicos indicam que a família não é monofilética e o grupo-irmão aindaindeterminado (Rognes 1997). Além disso, as relações filogenéticas entre subfamílias, e dentro delas, estão longe de ser completamente resolvidas, inclusive com dados moleculares (Kutty *et al.* 2010; Singh & Wells 2011; Marinho *et al.* 2012). Calliphoridae *sensu lato* foi tradicionalmente considerada composta por 12 subfamilias: Auchmeromyinae, Bengaliinae, Helicoboscinae, Melanomyinae, Phumosiinae, Calliphorinae, Chrysomyinae, Luciliinae, Mesembrinellinae, Poleniinae, Rhiniinae e Toxotarsinae (Rognes 1997). Por outro lado, alguns autores somente reconheceram duas subfamílias em classificações mais conservadoras (Shewell 1987). Embora num sentido mas amplo seja um táxon parafilético ou polifilético, a fauna neotropical é recuperada como monofilética, desde que Mesembrinellinae seja excluído. Este último táxon foi recentemente reestabelecido e novamente elevado à categoria de família (Marinho *et al.* 2016). Desta maneira, considera-se atualmente a proposta de cinco subfamílias ocorrendo na região Neotropical; Calliphorinae, Chrysomyinae, Luciliinae, Toxotarsinae e Melanomyinae, sendo esta última restrita à América Central (Whitworth 2010; Kosmann *et al.* 2013).

A identificação de táxons supraespecíficos da região Neotropical é uma tarefa relativamente simples e confiável, devido à disponibilidade de chaves taxonômicas de diversos autores (Dear 1979, 1985; Mariluis 1981; Dale 1987; Mello 2003; Amat *et al.* 2008; Whitworth 2010; Kosmann *et al.* 2013), exceto em alguns casos, como por exemplo em *Paralucilia* e *Chloroprocta*, onde as semelhanças entre táxons pode confundir a determinação taxonômica. Entretanto, para a identificação ao nível especifico, na maioria de casos se faz necessário a análise de caracteres da genitália masculina, e a combinação de caracteres morfológicos para as fêmeas (Shewell 1987). Embora os caracteres de genitália sejam importantes, poucos estudos têm explorado o uso da genitália feminina na diagnose das espécies (Rognes 1991).

Histórico

A história taxonômica dos califorídeos neotropicalis é longa e cheia de imprecisões e erros na identificação de espécies, além de excessivas divisões propostas a nível genérico. Além disso, varios autores usaram diferentes nomes e classificações para os mesmos taxa (Vargas & Wood 2010). Contudo, vale a pena destacar os estudos dos primeiros dipterólogos europeus e norte-americanos que descreveram a maioria das espécies do grupo, e autores desde meados da década de 20, que tentaram resumir a fauna da família, como Shannon (1926), Hall (1948) e James (1970). Recentemente, a fauna da América Central foi apresentada no Manual of Central American Diptera (Vargas & Wood 2010) e a fauna das Antilhas por Whitworth (2010). Similarmente, várias revisões taxonômicas foram essenciais ao conhecimento atual do grupo, por exemplo, o gênero *Calliphora* foi estudado estudada por Mello (1962, 1974) e Whitworth (2012), Chrysomyiini foi revisada por Dear (1985) e os gêneros neotropicais *Compsomyiops*, *Hemilucilia* e *Paralucilia* revisados por Mariluis *et al.* (1994), Mello (1996), Peris & Mariluis (1989) e González-Mora *et al.* (1998) respetivamente. *Lucilia* (= *Phaenicia*) foi estudado por Mello (1961) e Mariluis *et al.* (1994) e finalmente a subfamília Toxotarsinae foi estudada por Mello (1978) e Lopes & Albuquerque (1982) e revisada por Dear (1979).

Além de toda essa literatura taxonômica, nas últimas duas décadas, vários estudos ecológicos e faunísticos contribuíram consideravelmente ao conhecimento da fauna dos califorídeos do noroeste da América do Sul, dentre estes valem serem mencionados os estudos nos Andes peruanos por Baumgartner & Greenberg (1985), nos Andes colombianos por Amat & Wolff (2007), Amat (2009) e Montoya-G *et al.* (2009) e na região Amazônica por Paraluppi & Castellón (1993), Paraluppi (1996), Amat (2010), Esposito *et al.* (2010) e Ururahy-Rodrigues Rafael & Pujol-Luz (2013). Listas de espécies, sinopses e catálogos foram compilados para a fauna da Colômbia por Pape *et al.* (2004), Ramírez-Mora *et al.* (2012), Salazar-Ortega *et al.* (2012) Wolff & Kosmann (2016) para a Venezuela por Cova (1964) e Velásquez *et al.* (2017) e para o Estado do Amazonas por Amat *et al.* (2016). Do mesmo modo, com o desenvolvimento da entomologia forense na região, um número considerável de estudos da fauna cadavérica, padrões de sucessão em carcaça de suíno, ciclo de vida de espécies e listas de insetos de interesse forense tem contribuído valiosamente ao conhecimento da biologia e a bionomia das espécies de moscas, muitos desses foram compilados e podem ser consultados em Mavárez-Cardozo *et al.* (2005), Amat & Gomez-Piñerez (2012), Ururahy-Rodrigues *et al.* (2013) e Salazar & Donoso (2015)

Biologia e importância

A importância dos califorídeos se deve ao alto grau de associação com o homem (Marshall 2012). A maioria das espécies são de importância médica, veterinária ou sanitária, devido ao fato de serem atraídas por excrementos, secreções e qualquer outro tipo de material orgânico em decomposição, assim como pelo contato próximo a alimentos humanos, tornando-se eficientes vectores mecânicos de diversos patógenos (Greenberg 1971). Espécies como *Cochliomyia hominivorax* (Coquerel, 1858) causam miíases, doença causada por infestação de larvas no tecido animal vivo, que pode afetar tanto humanos como outros animais (Norris 1965). No contexto da ecológico, em especial no processo de decomposição, as moscas são os organismos mais ativos e conspícuos no processo de redução de carcaças (Anderson & Cervanka 2002). Esta característica faz com que estes insetos sejam o grupo de organismos insetos mais utilizados na entomologia forense, onde características ecológicas intrínsecas de cada espécie são utilizadas como relógio biológico no cálculo do IPM -*Intervalo pós-morte*-, que auxiliam em casos criminais (Greenberg & Kunich 2002; Amendt *et al.* 2004). Além disso, as larvas de algumas espécies são usadas por culturas ancestrais no tratamento terapêutico de feridas crônicas, técnica conhecida atualmente como larvoterapia, bioterapia ou biocirurgia (Sherman 2003). Também são organismos que desempenham papeis benéficos para a agricultura, pois são efetivos polinizadores de árvores frutíferas, afetando positivamente na qualidade e quantidade de frutos (Saeed *et al.* 2016).

As espécies de Calliphoridae apresentam diferentes aspectos de tolerância as condições do habitat, sendo claramente afetadas pelo grau de impacto humano no ambiente natural (antropização). Assim, no contexto entomológico seu nível de preferência é conhecido como sinantropia (Gregor & Povolný 1958) Atualmente são aceitadas três categorias; assinantrópicas, hemissiantrópicas e eussinantrópicas, que classificam as moscas segundo o grau de atração ou repulsão aos assentamentos humanos (Greenberg 1971). Na literatura é comum o cálculo do índice de sinantropia (I.S), cujos valores variam do extremo negativo -100 para espécies que evitam os assentamentos humanos ao extremos positivo +100 para espécies com altas afinidades aos assentamentos humanos (Nuorteva 1963). Além disso, no contexto conservacionista, estudos demostram uma correlação entre a composição das assembleias de moscas e os processos de restauração florestal (de Sousa *et al.* 2014). Estudos de monitoramento de mamíferos têm utilizado métodos indiretos para avaliar sua diversidade em florestas tropicais. A técnica baseia-se na utilização de sequências curtas de DNA, conhecidas como mini-barcode, de material extraído do sistema digestivo das moscas (Lee *et al.*, 2015).

A identificação correta de organismos é essencial para a utilização adequada dos táxons nos mais diversos campos mencionados. Os recentes avanços na utilização de ferramentas moleculares têm possibilitado auxiliar na resolução de vários problemas taxonômicos, destacando-se entre estes a utilização do DNA barcode, que pode ser aplicado aos mais diversos grupos taxonômicos (Hebert *et al.* 2003). Neste contexto, as moscas não são exceção, inclusive os dipterólogos foram os primeiros pesquisadores à incluir sequências de DNA em descrições taxonômicas (Meier & Zhang 2009). Assim, estudos moleculares bem sucedidos com moscas caliptradas são publicados desde a década de 90 (Sperling *et al.* 1994) até hoje (Zajac *et al.* 2016). Contudo, são pouco os estudos genéticos com a fauna neotropical e inexistentes para alguns táxons de distribuição andina. Apesar de toda literatura disponível e a grande importância das moscas, a fauna de Calliphoridae na região noroeste da América do Sul não foi estudada em um sentido biogeográfico abrangente, poucos estudos avaliaram os padrões espaciais ao longo de gradientes altitudinais, latitudinais ou sinantrópicos. Situação similar ocorre igualmente para estudos ecológicos sobre sazonalidade e genéticos sobre a identificação de espécies com dados moleculares.

A região norte da America do Sul possui uma complexa estrutura geomorfológica, fitogeográfica e hidrologica, refletida numa alta diversidade florística e de habitats, organizados ao longo de gradientes ambientais arranjados em espaços pouco distantes (Gentry 1982). Mais exatamente com referenca aos Andes tropicais, este é considerado um dos mais importantes *hot spots* de diversidade mundial (Mittermeier *et al.* 2004), especialmente os seus ecossistemas associados: floresta montanhosa úmida, floresta pluvial montanhosa, floresta alto montana e o singular ecossistema do Páramo entre outros (Holdridge 1967). Não obstante, é inquestionável a diversidade das florestas de terras baixas como a Amazônica e a Pacífica. No noroeste da América do Sul convergem seis diferentes sub-regiões naturais de relevância biológica, cujos limites espaciais podem variar de acordo com a proposta de regionalização (Hernández-Camacho & Sanchez-Páez 1992; Rivas-Martinez *et al.* 2011; Morrone 2014).

Assim a diversidade das assembleias de califorídeos, seus padrões de distribuição geográfica junto ao uso de dados moleculares na identificação das espécies que ocorrem no noroeste da América do Sul são objeto deste estudo. Para abordar a temática da composição de assembleias locais nesta área, foram escolhidos três cenários na região Amazônica e Andina, respectivamente, o que correspondem aos três primeiros capítulos da tese. O primeiro capítulo avalia a composição da fauna de moscas na região de interflúvios do rio Amazonas (Brasil) e o seu efeito nas assembleias de moscas. O segundo capítulo apresenta a composição de espécies no gradiente altitudinal na Sierra Nevada de Santa Marta (maior montanha costeira do mundo). O terceiro capítulo apresenta a composição e a sazonalidade da assembleia num ambiente típico de Páramo andino durante o período de dois anos de coleta. O quarto capítulo apresenta informações geográficas e padrões de distribuição dos califorídeos com base em dados de espécimes depositados em onze coleções entomológicas locais. Finalmente, o quinto capítulo avalia a performance de dados moleculares, mais especificamente sequências curtas de DNA mitocondrial (mini-barcode), na identificação de espécies de Calliphoridae.

OBJETIVOS

Objetivo geral

Estudar a fauna de Calliphoridae no noroeste da América do Sul,com foco na diversidade local de algumas assembleias, composição, distribuição geográfica das espécies e identificação de espécies por DNA mitocondrial.

Objetivos específicos

- Inventariar a fauna de Calliphoridae e propor padrões preliminares de distribuição das espécies de Calliphoridae baseado em regiões biogeográficas.
- Avaliar a diversidade de Calliphoridae na região do interflúvio Amazônico.
- Comparar a diversidade de Calliphoridae no gradiente atitudinal na região Andina do noroeste da América do Sul.
- Avaliar a diversidade de Calliphoridae no ecossistema de Páramo na região Andina da America do Sul.
- Identificar padrões de sazonalidade das espécies no ecossistema de Páramo
- Testar o uso de sequencias de DNAmitocondrial (minibarcode) na identificação das espécies de Calliphoridae da região norte da América do Sul.

Capítulo 1

Amat, E. Marinho, M. A. T. & Rafael, J.A. 2016. A survey of necrophagous blow flies (Diptera: Oestroidea) in the Amazonas-Negro interfluvial region (Brazilian Amazon). *Revista Brasileira de Entomologia* 60:57-62.

A survey of necrophagous blow flies (Diptera: Oestroidea) in the Amazonas-Negro interfluvial region (Brazilian Amazon)

Eduardo Amat[a-b], Marco A. T. Marinho[c] & Jose A. Rafael[a]

[a] Laboratorio de Sistemática de Diptera, Instituto Nacional de Pesquisas da Amazônia (INPA),AM, Brazil.

[b] Grupo de Investigación Ciencias Forenses y Salud, Facultad de Investigación Judicial, Forenses y Salud, Tecnológico de Antioquia Institución Universitaria, Antioquia, Colombia.

[c] Faculdade de Filosofia, Ciência e Letras de Ribeirão Preto (FFCLRP), Universidade de São Paulo (USP),Riberão Preto, SP, Brazil.

*Corresponding author.

E-mail: ecamat@gmail.com (Amat E).

Abstract

The fauna of blow flies (Calliphoridae and Mesembrinellidae) in three localities of primary Amazon forest coverage, in the Amazonas-Negro interfluvial region was assessed. A total of 5.066 blow flies were collected, being *Chloroprocta idiodea* the most abundant species (66.3%). No difference in abundance and species richness between the localities was observed. The fauna of necrophagous flies did not vary between the sampled sites, except for the species *Eumesembrinella benoisti* (Séguy, 1925) and *Hemilucila* sp., whose occurrence was observed only in a single locality. Apparently, Amazon rivers are not efficient current or historical geographical barriers that influence the composition of necrophagous blow fly assemblages. Also, blow flies did not show a noticeable specificity for the type of forest between the interfluvial areas. Finally, an updated checklist of necrophagous blow flies species of the Amazonas state in Brazil, is presented.

Key Words: Blow fly Assemblage, Calliphoridae, Diversity, Forensic Entomology, Mesembrinellidae

Introduction

Necrophagous flies of the family Calliphoridae (Diptera: Calyptratae: Oestroidea) are among the first insects to detect, arrive and colonize animal carcasses in many distinct environments (Hansky 1987; Amendt *et al.* 2004). In addition they have a very important role in the decomposition process (Keh 1985; Smith 1986; Catts & Haskell 1991; Souza de & Linhares 1997; Oliveira-Costa 2008), species from this family are also of major importance to forensic and medical issues, in the latter for being carriers of many pathological microorganisms (Greenberg 1971; Amendt *et al.* 2004; Sawabe *et al.* 2011). Mesembrinellidae (Diptera: Calyptratae: Oestroidea) a group historically treated as a subfamily of Calliphoridae appears to have a different biology, they are viviparous and larvae seems to have parasitoids preferences; nevertheless adults are strongly attracted to dung and carrion, and clearly all species shows preferences to inhabit pristine forests (Guimarães 1977).

In forensic and legal matters, knowledge about the distribution and the tolerance to different ecological parameters of these necrophagous species is crucial to infer the local in which death, or at least the beginning of the decomposition, took place, as well as to estimate the post-mortem interval –PMI- (Greenberg 1991; Amendt *et al.* 2004; Oliveira-Costa & Mello-patiu 2004; Rocha *et al.* 2009). Most of this knowledge, however, cannot be easily extrapolated to different localities and usually depends on the degree of conservation of a particular environment (Zabala *et al.* 2014).

Species in these families have different tolerances to environmental conditions, being affected by the proximity to human populations (synanthropy) and disturbances in primary vegetation coverage. More so for species of Mesembrinellidae, which are absent in synanthropic and disturbed natural environments (Povolný 1971; Esposito *et al.* 2010). Also, they present distinct dispersal rates and fly capabilities, with elements from the environment that may act as barriers to some, but not all, species (Macleod & Donelly 1960; Tsuda *et al.* 2009). In the Amazonian rainforest, large rivers constitute one of the barriers, historical or current, to dispersal in different groups of winged animals, such as birds (Hayes & Sewlal 2004), even though the dynamics of isolated populations may present many other historical causes (Haffer 1997). Data on flight and dispersal capacity in blow flies is scarce, but the studies conducted so far indicate that they can fly for very long distances; varying in a single flight between 100 to 700 m for *Lucilia* species and from 1,250-1,789 m, and as far as 3,500 m/day, for *Calliphora nigribasis* (Tsuda *et al.* 2009). Moreover, rivers as wide as 182.88 meters and slopes as high as 152.40m (500 feet) do not seem to act as barriers to the dispersal of blow flies (Macleod & Donelly 1960).

In the Amazonas state (Brazil), the Amazon River and its tributaries, which probably originated circa 5 Mya with the uplifting of the Andes (Hoorn *et al.* 1995; Campbell *et al.* 2001), were already implicated as historical barriers for dispersal and account for the different distributions of some bird species in the region (Haffer 1997; Hayes & Sewlal 2004). For flies, it could also be an important barrier, since in its wider portions the river can be more than 40 Km wide during the rainy season. In this context, this study surveyed the blow fly fauna in the interfluvial region of the Amazonas-Negro rivers, with a comparison between the species richness and abundance of the necrophagous fly fauna in the sampled localities.

Material and Methods

Van Sommeren-Rydon traps, modified to collect flies, were mounted in three localities of the interfluvial region of the Amazonas-Negro rivers between December 1st-15th, 2013 (Figure 1). All localities comprised regions of typical Amazonian rainforest phytophysiognomy (dense ombrophgilous forest - Veloso *et al.* 199): (1) the ZF2 biological reserve, located at 50 Km from the major urban center in the Manaus municipality; and private properties in the municipalities of (2) Novo Airão and (3) Careiro Castanho. In each locality, 4 to 7 traps were used, baited with a mixture of decomposing cow, chicken and fish viscera. Traps were emptied after 2-3 days and all flies collected were counted and identified following the keys provided by Amat *et al.* (2008), Kosmann *et al.* (2013), Whitworth (2014) and Wolff *et al.* (2014).

Data from the different localities were analyzed for relative and total abundance distribution using the IBM-SPSS Statistics (2012) software. Sampling efficiency and representation were assessed using curves for species accumulation, ICE (incidence-based coverage estimator), the Jack1 and the Chao1 non-parametric estimators of total species richness, using the Estimates 9.0.1 software (Colwell 2013). Non-parametric Kruskall-Wallis tests were used in order to evaluate if there were significant differences in richness and abundance between the localities. Co-occurrence and spatial assemblage structure were assessed using the C-score of Stone & Roberts (1990) using EcoSim software (Entsminger 2014). Species reported here and a review of literature served to to compile the updated check list.

Results

A total of 6,772 dipterans were collected, with Calliphoridae being the most abundant (4,356 specimens - 64.3%), followed by the families Muscidae (715 - 10.5%), Mesembrinellidae (710 - 10.4%), Sarcophagidae (325 - 4.7%) and Fanniidae (203 - 2.9%). Other Diptera families comprised 463 individuals (6.8%). Of the 5,066 blow fly specimens (Calliphoridae and Mesembrinellidae) collected, 10 were species of Calliphoridae: *Chrysomya albiceps* (Wiedemann, 1819), *Chrysomya putoria* (Wiedemann, 1818), *Chrysomya megacephala* (Fabricius, 1794), *Chloroprocta idioidea* (Robineau-Desvoidy, 1830), *Cochliomyia macellaria* (Fabricius, 1775), *Paralucilia paraensis* (Mello, 1969), *Hemilucilia segmentaria* (Fabricius, 1805), *Hemilucilia* sp. and *Lucilia eximia* (Wiedemann, 1819) and 3 were of Mesembrinellidae (*Eumesembrinella benoisti* (Séguy, 1925), *Eumesembrinella randa* (Walker, 1849) and *Mesembrinella bellardiana* Aldrich, 1922. Both the rarefaction curve (Figure 2) and the values of the species richness estimators, ICE, Chao1 and Jack1 (96%) (Table 1), indicated that collecting sites and the complete area assessed were well sampled.

Hemilucilia sp., a species found exclusively in the ZF2 locality, is probably a new species since the male genitalia does not match any of the described species of this genus (*sensu* Dear 1985) - data not shown). Excluding this species, sampled fauna comprised 12 out of the 18 species (66.6%) currently known for the Amazonas state (Table 2). Among these, the most abundant species was *Chl. idioidea* (66.3%), followed by *E. randa* (8.4%) and *H. semidiaphana* (5%), while *C. macellaria* and *Chr. megacephala* were the least abundant, represented by less than 25 individuals each (Figure 3). With the exception of the exclusive occurrence of *E. benoisti* in Novo Airão and *Hemilucilia* sp. in the ZF2 Reserve (Manaus), as well as the absence of *C. megacephala* in the latter, all species were found in the three localities with somewhat different abundances (Figure 4). Comparisons between localities showed that Novo Airão is slightly richer than the other two, presenting 12 out of the 13 sampled species, a fact also observed in the rarefaction curve for all localities (Figure 2).

Nevertheless, non-parametrical tests showed no statistically significant differences in both species abundance (Kruskall-Wallis; df = 2, P = 0.649) and richness (Kruskall-Wallis; df = 2, P= 0.059), even though the latter was only slightly higher than the critical p-value (0.05). The absence of a significant difference on species richness between the localities is coherent with the estimated C-score for co-occurrence (0.03845) being significant smaller than the critical simulated index (0.04157), indicating that necrophagous blow flies assemblages are spatially distributed at random.

Discussion

Diversity patterns of the blow fly assemblage are consistent with the trends found in previous studies for the Amazon region (Amat 2010; Esposito *et al.* 2010). The absence of significant differences in faunal composition, comprising also species abundance and richness, in the three sampled interfluvial localities may indicate that Amazon rivers are not barriers to fly dispersion, at least in a historical perspective. The three localities sampled are relatively similar in terms of forest physiognomy, possible differences found in this context does not seem to be a significant factor influencing this flies faunal assemblage. Rather, composition seems to be more affected by the closer proximity to urban centers, as shown by the presence/absence of *C. megacephala* in the sampling, an introduced species with high dispersion capacity and highly synanthropic habit (Prado & Guimarães 1982; Baumgartner & Greenberg 1985; Paraluppi & Castellón 1993; Paraluppi 1996). The remarkably low densities and abundance for the native species *C. macellaria* may reflect the effects of ecological competence with the introduction of *Chrysomya* species to the Americas, since *C. macellaria* used to be one of the most frequent species in neotropical environments and was the most abundant fly in the Peruvian rain forest from 1979 to 1981(Baumgartner & Greenberg 1985).

It is noteworthy the importance of assessing the effects of these invaders species on the native carrion fly communities in the Amazonian region.

Although there seems to be no evidence supporting the rivers as historical barriers affecting necrophagous dipteran assemblages distribution in this region, it is still possible that these rivers may constitute current barriers to gene flow, leading to significant differences in populations between interfluvial localities. An assessment of population structure and differentiation based on molecular data is being conducted and should provide further insights on this matter and also in the forensic context. Spatial distribution of blow flies are strongly affected by synantropic effects, dispersal capability and the local and specialized breeding sites of the immature stages (Norris 1965; Povolný 1971). These aspects must be taken into consideration in biogeographical inferences and probably account for a large extent of the patterns found in this study for the Amazonian forest.

The checklist provided here may serve as a baseline for future ecological studies and applications in the forensic entomology framework of the Amazon region, since a local fauna inventory is essential in this context. The number of Calliphoridae *sensu stricto* species reported here was fewer than that reported by Ramírez-Mora *et al.* (2012) in a one-year faunal survey study in a smaller area in the Andean region. These findings indicate the lack of intensive collection efforts and the little knowledge currently available about the fauna of one of the world’s major megadiversity hot-spots.

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Conflicts of interest

The authors declare no conflicts of interest.

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Table 1. Species richness estimators for each site and for the complete area of study. **Nt** = number of traps; **Ns** = number of species; **Ni** = number of individuals. **ICE** = incidence-based coverage estimator; **Chao1** and **Jack1** = 1st order Chao and Jacknife, respectively. **%** = Percentage of the total expected number of species.

Site	Nt	Ns	Ni	ICE	Chao1	Jack1	Mean- ± SD	%
Careiro Castanho	4	11	550	11.43	11	11.75	11.4±0.4	96.5
Novo Airão	6	12	1031	12.41	12	12.83	12.4±0.4	96.7
ZF2	7	11	3479	11.43	11	11.86	11.4±0.4	96.2
Complete area	17	13	5060	13.32	13	13.94	13.4±0.5	96.9

Table 2. Updated checklist of necrophagous blowflies (Calliphoridae and Mesembrinellidae) of Brazilian Amazonas province. **RFAD** = Reserva Florestal Adolfo Ducke; **Ca** = Careiro Castanho; **Co** = Coari; **Mao** = Manaus; **NvA** = Novo Airão.

Taxon	Sites sampled in this study	Municipality	Locality	Bait	Reference
Calliphoridae					
Chrysomyiinae					
Chloroprocta idiodea (Robineau-Desvoidy 1830)	All	Ca, Co, Mao, NvA,	RFAD, Urucu	Cow, pig, fish and chicken viscera	Paraluppi 1996; Esposito *et al.* 2010; Ururahy-Rodrigues *et al.* 2013
Chrysomya albiceps (Wiedemann 1819)	All	Ca, Co, Mao, NvA,	RFAD, Urucu	Cow, pig, fish and chicken viscera	Paraluppi 1996; Barros-Souza *et al.* 2012; Esposito *et al.* 2010; Ururahy-Rodrigues *et al.* 2013
Chrysomya megacephala (Fabricius 1794)	Careiro, Novo airao	Ca, Co, Mao, NvA,	RFAD, Urucu	Cow, pig, fish and chicken viscera	Paraluppi & Castellon 1993; Paraluppi 1996; Esposito *et al.* 2010; Barros-Souza *et al.* 2012
Chrysomya putoria (Wiedemann 1818)	All	Ca, Co, Mao, NvA,	Manaus city, Urucu	Cow, pig, fish and chicken viscera	Paraluppi & Castellon 1993; Paraluppi 1996
Cochliomyia macellaria (Fabricius 1775)	All	Ca, Co, Mao, NvA,	Manaus city, Urucu	Cow, pig, fish and chicken viscera	Paraluppi & Castellon 1993; Paraluppi 1996; Esposito *et al.* 2010; Ururahy-Rodrigues *et al.* 2013
Hemilucilia segmentaria (Fabricius 1805)	All	Ca, Co, Mao, NvA,	Manaus city, Urucu	Cow, pig, fish and chicken viscera	Paraluppi 1996; Esposito *et al.* 2010; Barros-Souza *et al.* 2012; Ururahy-Rodrigues *et al.* 2013
Hemilucilia semidiaphana (Rondani 1850)	All	Ca, Co, Mao, NvA,	Manaus city, Urucu	Cow, pig, fish and chicken viscera	Paraluppi 1996, Esposito *et al.* 2010; Ururahy-Rodrigues *et al.* 2013
Hemilucilia souzalopesi (Mello 1972)	-	Mao	Manaus city	Pig	Ururahy-Rodrigues *et al.* 2013
Hemilucilia sp.	ZF2	Mao	ZF2	Fish and chicken viscera	this study
Paralucilia paraensis (Mello 1969)	All	Mao, Co	Manaus city, Urucu	Cow, pig, fish and chicken viscera	Esposito *et al.* 2010; Barros-Souza *et al.* 2012
Paralucilia sp.	-	Mao	RFAD	Pig	Ururahy-Rodrigues *et al.* 2013
Luciliinae					
Lucilia albofusca (Withworth 2014)	-	Mao	RFAD	Flight trap	Withworth 2014
Lucilia eximia (Wiedemann 1819)	All	Ca, Co, Mao, NvA,	Manaus city, RFAD, Urucu	Cow, pig, fish and chicken viscera	Paraluppi 1996; Esposito *et al.* 2010; Barros-Souza *et al.* 2012; Ururahy-Rodrigues *et al.* 2013

Table 2. (Continuation) Updated checklist of necrophagous blowflies (Calliphoridae and Mesembrinellidae) of Brazilian Amazonas province. **RFAD** = Reserva Florestal Adolfo Ducke; **Ca** = Careiro Castanho; **Co** = Coari; **Mao** = Manaus; **NvA** = Novo Airão.

Taxon	Sites sampled in this study	Municipality	Locality	Bait	Reference
Mesembrinellidae					
Eumesembrinella benoisti (Séguy, 1925)	Novo airao	Ca, Mao, NvA,	RFAD	Pig, fish and chicken viscera	Ururahy-Rodrigues *et al.* 2013
Eumesembrinella quadrilineata (Fabricius 1805)	-	Co	Urucu	Cow viscera	Esposito *et al.* 2010
Eumesembrinella randa (Walker 1849)	All	Ca, Co, Mao, NvA,	Urucu	Cow, fish and chicken viscera	Esposito *et al.* 2010
Mesembrinella batesi (Aldrich 1922)	-	Co	Urucu	Cow viscera	Esposito *et al.* 2010
Mesembrinella bellardiana (Aldrich 1922)	All	Ca, Co, Mao, NvA,	Urucu	Cow, fish and chicken viscera	Esposito *et al.* 2010
Mesembrinella bicolor (Fabricius 1805)	-	Co	Urucu	Cow viscera	Esposito *et al.* 2010

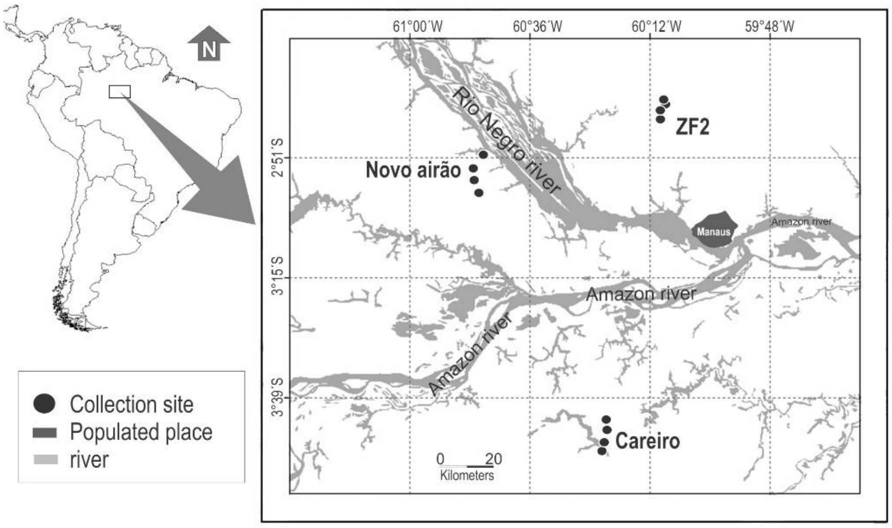

Figure 1. Collecting sites and sampling points in the Amazonas state, Brazil.

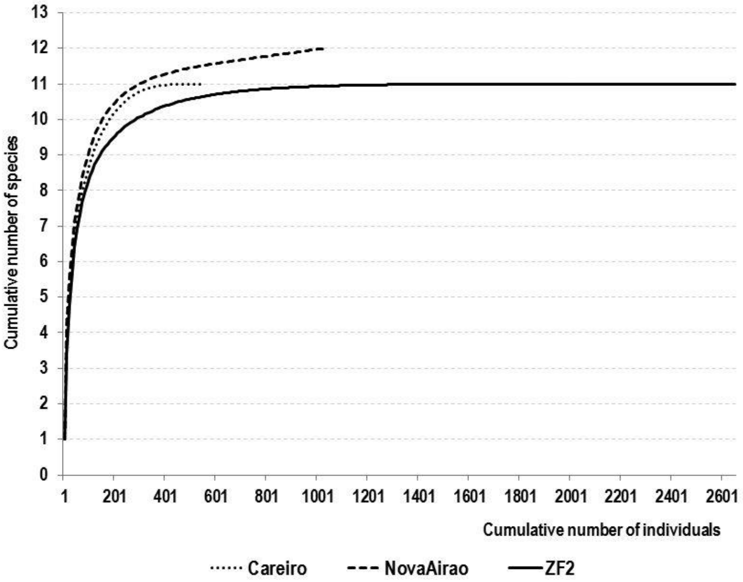

Figure 2. Rarefaction curve for necrophagous blow flies in the three interfluvial collecting sites.

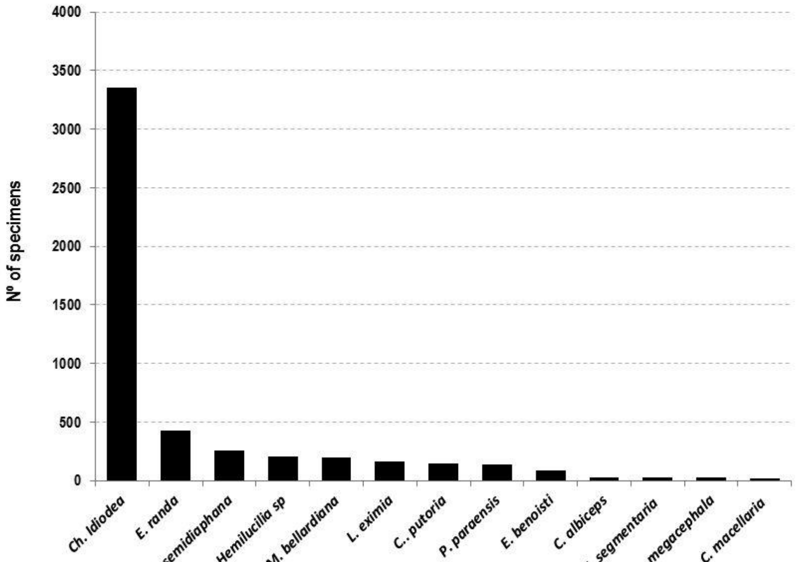

Figure 3. Species abundance distribution of necrophagous blow flies in the Amazonas-Negro interfluvial region.

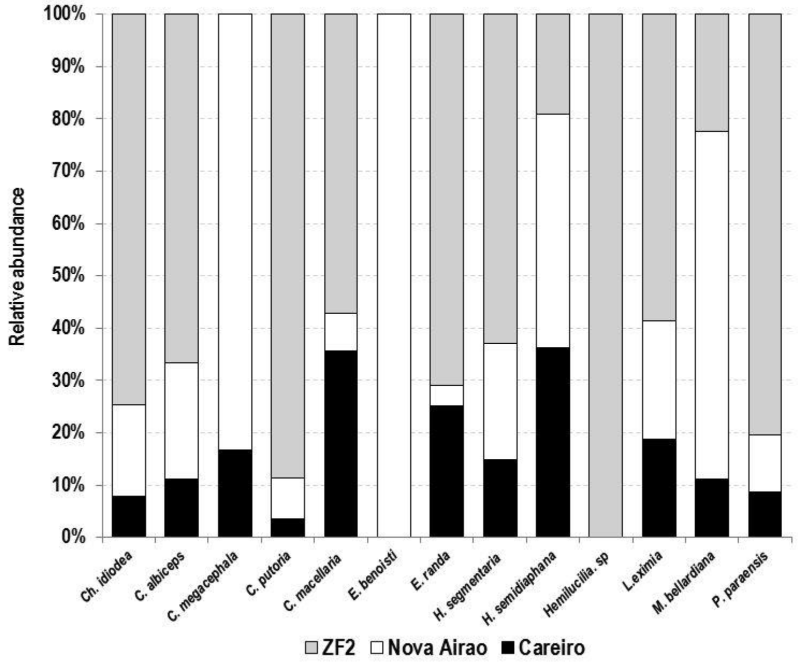

Figure 4. Relative abundance of necrophagous blow flies in each of the three interfluvial collecting sites.

Capítulo 2

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E. Amat
Programa de Pós-Graduacão em Entomologia,
Coordenacão de Entomologia, Instituto
Nacional de Pesquisas da Amazônia-INPA,
Manaus, AM, Brazil. Av. André Araújo, 2936
- Aleixo - CEP 69.060-001 - Manaus, AM,
Brasil. E- mail: ecamat@gmail.com

The carrion-breeding blow flies (Diptera: Oestroidea) of the Sierra Nevada de Santa Marta, Colombia.

E. Amat[1,2] A. Perez-Hoyos[2] and J.A. Rafael[1]

[1]Programa de Pós-Graduacão em Entomologia, Coordenacão de Entomologia, Instituto Nacional de Pesquisas da Amazônia-INPA, Manaus, AM, Brazil

[2]Grupo de Investigación Ciencias Forenses y Salud (GICFS), Tecnológico de Antioquia-Institución Universitaria, Medellín, Colombia

Abstract

Diversity of carrion-breeding blow flies based on the effective number of species among four biomes (Montane wet forest; Premontane moist forest, Tropical dry forest and a Urban area) and eight altitudinal categories along an elevation range from 20 to 1600m a.s.l at the Sierra Nevada de Santa Marta (SNSM) northern Colombia, was assessed. The most common species was the exotic *Chrysomya albiceps* (38%). Richness was remarkably high if considering the geographical scale; the richest biome (^{0}D) was the montane wet forest enclosing nine species and the poorest was the urban area with four species. The compositional similarity in terms of sharing species among the four biomes was intermediate (^{0}D=0.48). Faunal distribution and turnover were more evidenced by biome variation than by the altitudinal range. An updated species checklist of the blow flies' inhabitant the SNSM is offered and their geographical distribution and synanthropy is briefly discussed. The spatial and biomes heterogeneity found in the SNSM is the most significant factor to explain the current diversity of carrion-breeding blow flies. Mesembrinellid flies were all asynanthropic and exclusives to montane wet forest and for conservational purposes they may act as indicators of undisturbed Andean forest. Faunistic and ecological data of neotropical carrion-feeding blow flies is offered for practical application in forensic, medical and conservational context.

Key Words: Altitudinal gradient, Calliphoridae, Colombian Andes, Hill numbers, Mesembrinellidae.

Resumen

Se evaluó la diversidad de moscas califóridas según el número efectivo de especies (Numeros de hill) en cuatro biomas (Bosque lluvioso montano, bosque húmedo premontano, bosque seco tropical y un área urbana) y ocho categorías de elevación desde los 200 a los 1600 msnm de la Sierra Nevada de Santa Marta (SNSM) en la región norte de Colombia. La especie más común fue Chrysomya albiceps (38%). La riqueza de la región es considerablemente alta dada la escala geográfica estudiada; el bioma más rico en especies (0D) fue el Bosque lluvioso montano con nueve especies, mientras el más pobre fue el área urbana con solamente cuatro. El nivel de similitud en términos de especies compartidas por bioma fue intermedio (0D=0.48). La distribución y recambio de la fauna fue más evidente según el bioma estudiado que por rango de elevación. Se presenta una lista actualizada de las especies de moscas carroñeras de la SNSM, junto con una breve discusión sobre su distribución geográfica y sinantropía. La heterogeneidad espacial y de biomas encontrada en la SNSM es el principal factor para explicar la actual diversidad de moscas califóridas. Las moscas Mesembrinellidae resultaron ser asinantrópicas y exclusivas del bosque lluvioso montano por tanto la presencia de este grupo puede sugerir áreas poco perturbadas con fines de conservación. Se presenta información ecológica y faunística sobre estas moscas de distribución neotropical para estudios en el campo aplicado de la entomología médica, forense y en el contexto de la conservación.

Introduction

In the framework of the ecological decay and decomposition process of organic matter in the ecosystems, the carrion-breeding blow flies of Calliphoridae (Calyptratae: Oestroidea) have a great ecological importance. They are one of the most conspicuous and active macro-organisms in the process of carcass animal reduction (Anderson & Cervanka, 2002; Norris, 1965). Also, they are the most important insects used in forensic entomology due to their carrion colonization habits, behavior that may serve as a biological clock measuring the *post mortem interval* –PMI– (Amendt *et al.*, 2004; Greenberg & Kunich, 2002). Beside their ecological significance, most species are of medical, veterinary or sanitary importance; they are strongly attracted to excrement, secretions and decaying material, thus constantly alternating between feces and comestibles, which turns them into efficient mechanical vectors of pathogens (Greenberg, 1971). Others causes myiasis (infestation of tissue with fly larvae) in animals and man (Norris, 1965). On the other hand, blow flies were used by ancient cultures for therapeutic treatment of chronic wounds; this techniques were recovered and nowadays is known as larval therapy, biotherapy or biosurgery (Sherman, 2003). Also, they have been demonstrated as efficient fruit tree pollinators, driven a positive impact into the quality and quantity of the fruit (Saeed *et al.*, 2016). And lately, blow flies were used as an efficient indirect method for monitoring the diversity of mammals in tropical forests, based on mini-target mtDNA remainders allocated in the blow fly gut (Lee, Sing, & Wilson, 2015).

Blow flies have different tolerances to the habitat conditions, being affected by the degree of human impact on the natural environment (anthropization process), the level of preference commonly known in entomology as “synanthropy” (Gregor & Povolný, 1958); thus, synanthropic, hemysinantropic and asynanthropic are the ecological categories for classifying flies according to their degree of attraction or repulsion for human settlements (Greenberg, 1971). Patterns of species occurrence and their responses in assemblage composition had been suggested to be related with the Amazonian forest restauration process (de Sousa *et al.*, 2014) and with the effect of the urbanization (Kavazos & Wallman, 2012). Amat *et al.* (In press) found a decreasing trend in diversity of carrion flies assemblages along an anthropic gradient in the Andean Páramo ecosystem and they suggested that composition and species occurrence may serve as a practical indicator of anthropization in high Andean environments in the context of forensics and conservational studies.

Entomological studies of the Andean diversity of communities, assemblages composition, the species richness tendencies along gradients, species turnover and other ecological aspects are scarce (Larsen, Escobar, & Armbrecht, 2011). The carrion-breeding blow flies are not the exception, although in the las decade a considerable number of studies in the Andes were published as a consequence of the forensic entomology development (Amat & Gomez-Piñerez, 2012; Grisales, Ruiz, & Villegas, 2010), unfortunately these short-term approaches based on pig carcasses are suitable and commonly used for successional studies and carrion insect fauna characterization, but inappropriate to assess diversity patterns, seasonality and spatial distribution of carrion flies, because they dramatically underestimate the local species richness of carrion-breeding blow flies in this biogeographical region (Ramírez-Mora *et al.*, 2012) and may involve exaggerated logistics problems in the field and ethics when a high number of replication in time and space is needed (Schoenly, Michaud, & Moreau, 2016) . Long term Andean studies based on the composition, structure, and dynamics of the carrion feeders flies assemblages in all stages of decomposition process are needed to fairly understand and apply the biological data in the forensic and conservation context (Salazar-Ortega *et al.*, 2012).

The Sierra Nevada de Santa Marta (SNSM) is the highest coastal mountain of the world and was selected to address a preliminary survey on carrion-breeding blow flies assemblages along an altitudinal gradient and enclosing four types of biomes: The montane wet forest, Premontane moist forest, Tropical dry forest and a Urban area. Given its altitudinal variation from 0 to 5500 m.a.s.l it is able to found a complete variety of climates and biomes; in a relative short distance the landscape turns rapidly from a xerophytic dry tropical forest, to a moist or wet montane forest for finally become the Páramo and the perpetual snows (Rangel-Ch & Garzon-C, 1995). The SNSM is an ideal scenario to assess the spatial distribution and altitudinal variation patterns in the Andean range. The biotic diversity of the SNSM is considerable high and is one of the nine areas with the greatest rate of endemism in Colombia (Hernández-Camacho & Sanchez-Páez, 1992; Tribin, Rodriguez-N, & Valderrama, 1999).

Additionally, some authors considered this montane system as a floral and faunal refugee of the Pleistocene (Tribin *et al.*, 1999). Most of the current knowledge of the insect's fauna inhabiting the SNSM is based on taxonomical studies, taxa revisions, description of new species or check lists published since the beginning of the twenty century. Ecological or faunistics studies on insects communities in the SNSM are scarse, some early studies were of butterflies (M. Adams, 1973; M. J. Adams & Bernard, 1977), others with scarab beetles (Howden & Campbell, 1974); Carabids (Carabidae) (Camero, 2003), dung beetles (Martínez, García, Pulido, Ospino, & Harváez, 2009), ants (Guerrero & Sarmiento, 2010); and particularly with flies, only one study on blackflies (Simuliidae) was done by Lewis and Lee-Potter (1964).

Nowadays in Colombia, fifty-two species of blow flies (Calliphoridae and Mesembrinellidae) have been reported, distributed in twelve and seven genera respectively (Wolff and Kosmann, 2016). Species of Mesembrinellidae have been treated historically as a subfamily of Calliphoridae *sensu lato*. However, here we follow the original proposal of Guimarães (1977) who treats it as a separate family, as the well as recent studies demonstrated this group of flies as a monophyletic clade based on molecular data (Marinho *et al.*, 2016). In comparison with Calliphoridae, the reproductive system of Mesembrinellid females is highly modified, they are viviparous and some larvae seems to have parasitoids preferences; nevertheless adults are strongly attracted to dung and carrion, and clearly are asynanthropic; the species shows preferences to inhabit undisturbed forests (Guimarães, 1977). The first survey of the carrion-breeding blow flies' assemblages including diversity comparisons among ecosystems and altitudinal ranges, and the altitudinal species turnover and synanthropic tendencies of the species in the SNSM is presented. An updated check list of the carrion-feeding blow flies species inhabit the SNSM is compiled. We intend to offer a faunistic and ecological data of Andean carrion feeding flies for practical application in the forensic, medical and conservational context.

Materials and Methods

Study site

The Sierra Nevada de Santa Marta (SNSM) is an independent montane system of the Andean belt, and far the highest coastal mountain of the world, located in the northern Colombian province of Magdalena (Fig. 1). It rises from 0to 5775 m.a.s.l (Pico Cristobal Colon) at a distance of only 42 kilometers, it is shaped like a trihedral and covered an area of 17.000 km^2. The SNSM belongs to the Tropical Andean Biodiversity hotspot (R A Mittermeier *et al.*, 2004) containing a high variety of fauna and flora in a relative small complex of physiography heterogeneity with distinct evolutionary histories. The geographical isolation and the climatic conditions of it recent geological history may possible be hosting of a surprising diversity of fauna and flora and the development of a high level of endemism in mountain biomes located from 800 to 2.600 m acting as a continental Island (Cleef, Rangel-Ch, Van der Hammen, & Jaramillo-Mejia, 1984). The geomorphology and geological origin of the SNSM is extremely complex, including a combination of different rocks origin and uplift ages (Tschanz, Marvin, Cruz, Mennert, & Cebula, 1974) starting in the Cenozoic, with the most important uplift in the Paleocen-Eocen (64-45 Myr ago); then in the Oligocene (25-8 Myr ago) and finally in Late Miocene (from 8 Myr ago) (Cardona *et al.*, 2011). Nine types of life zones or biomes can be found along the altitudinal gradient; their vertical distribution depends not only of the climatic conditions, but topography and soil quality also may modify their distribution as in the rest of the Andean montane systems (Cleef *et al.*, 1984; Tribin *et al.*, 1999).

The study was conducted on the northwestern slope of the SNSM between locality N° 4 named Palangana (11°15'55.00"N - 74° 9'23.90"W) to the north, and the locality N° 1 known as Cincinati (11° 6′ 6,8″N - 74° 4′52,3″W) to the south. (Fig. 1, Table 1). Nineteen collection sites distributed in five localities ranging from 20 to 1600 m.a.s.l comprised three natural biomes and one highly anthropized (Urban) were assessed (Table 1). These were known as: Locality 1: Cincinati, belongs to the Tropical montane wet forest biome (MwF) according to Holdridge (1967); Montane cloud forest according to Adams (1973), Subandean forest according to Cuatrecasas (1989) and Sub-Andean forest orobiome according to Hernández-Camacho and Sanchez-Páez, (1992) classifications. The tree stratum at this area reach an altitude of the 35 meters, and they are mainly mainly dominated by the following woody plants: *Gustavia speciose*, *Sloane* sp and some palms *Dictyocaryum shultezei* ,*Geonoma* and *Chamaedorea* among others (Rangel-Ch & Garzon-C, 1995). Locality 2: Minca belongs to the Premontane moist forest biome (PmF) (Holdridge, 1967), Montane rain forest sensu (M. Adams, 1973), Inferior Forest (Cuatrecasas, 1989), Sub-Andean forest orobiome (Hernández-Camacho & Sanchez-Páez, 1992). According to Rangel-Ch and Garzon-C (1995) this site belongs to a pluvial forest with Poulsenio armatae-Perseetum americanae association, with the presence of giant trees of *Poulsenia armata* and *Persea americana* associated with *Ossaea cucullata* and *O. micrantha*. Localities 3 and 4: Bonda and Palangana belongs to the Tropical Dry Forest biome (TdF) sensu Holdridge (1967), Lowland forest and arid scrub sensu (M. Adams, 1973), Subxerophytic tropical zonal biome (Hernández-Camacho & Sanchez-Páez, 1992). The species *Bursera graveolens*, *B. simarouba*, *Pterocarpus marsupium Pradosia colombiana*, *Mimosa leiocarpa*, *Opuntia wentiana*, *Pereskia guamacho*, and *Gyrocarpus americanus* are the most common components in the tree stratum (Roca, 1986); these two localities comprehend a mosaic of natural patches and areas under different levels of anthropogenic effects. Locality 5: Santa Marta – originally belonged to the Tropical Dry Forest, now is a complete urban environment highly anthropized, placed within the city of Santa Marta. Traps in this location were settled within the campus of the Universidad de Magdalena, near to a cemetery and southern part of the town (Fig. 1), more detailed geographical and climatic information is consigned in the table 1.

Sampling was performed during the 26 February to the 3 March of 2013. In each locality it was settle 3- 4 Van Someren-Rydon traps modified for flies, baited with a mixture of two days old decomposing fish and chicken viscera. Traps were emptied after 48 hours and all of the collected flies were counted, tabulated and taxonomically identified following the keys provided by Amat *et al.*, (2008); Whitworth, (2010, 2014); Wolff, (2013) and Wolff *et al.*, (2014); pinned and labeled specimens were deposited at Colección Entomológica Tecnológico de Antioquia (CETdeA) located in Medellín, Colombia.

Data Analysis

The diversity data gathered for the complete area, four biomes and eight altitude categories were analyzed and compared based on observed diversity profiles and the effective number of species (Hill numbers) (A. Chao & Jost, 2015). Three values of diversity according the order of coefficient q were considered (the parameter q determines the measure of sensitivity to the species abundance), where q=0 for absolute number of species (Richness) and denoted as ^{0}D (D=Diversity), q=1 for the exponential of Shannon entropy denoted as ^{1}D and q=2 for the inverse of Simpson dominance and denoted as ^{2}D. The species richness estimations which were based on rarefaction by interpolation and extrapolation comparing biomes and altitudinal category jointly with Hills number allow to make reliable assemblages comparisons in any scale of time or space (A. Chao *et al.*, 2014). The sampling accuracy or inventory completeness was measured by using the sample coverage estimator proposed by (A. Chao & Jost, 2012) using iNEXT (A. Chao, Ma, & Hsieh, 2016) as follow

$$\hat{C}m = \left(1 - \frac{f_1}{n}\left[\frac{(n-1)f_1}{(n-1)f_1+2f_2}\right]\right) * 100,$$

Where n is the total of flies specimens, f_1 and f_2 singletons and doubletons respectively in the sample; $\hat{C}m$ values is expressed as a proportion and ranging from 0% to 100% when the completeness is maximum. As a measure of species inequality by biome and altitude category we follow the relative logarithmic inequality (RLI) proposed by Jost (2010) expressed as the logarithmic transformation of the inequality factor $\mathrm{IF}_{0,q}$

$$RLI_{0,q} = \frac{(\ln IF_{0,q})}{(\ln S)},$$

Where $\mathrm{IF}_{0,q}=(^{0}\mathrm{D}/^{2}\mathrm{D})$ and S is the α diversity, when $RLI_{0,q}$ tend to the unity it indicates maximum inequality. Synanthropic index (SI) as a measurement of the association to human settlement, was calculated for each species following Nuorteva (1963);

$$SI = (2a + b - 2c)/2$$

Where a= percentage of the fly species in the locality N°5 considered for urban environment, b= percentage of the same fly species in the locality N°3 for rural area, and c= percentage of the same fly specimens in the locality N°1 for forest area. SI range from -100 (avoidance for human settlements) to +100 (affinity for human settlements) according to the SI value, each species were categorized as eusynanthropic (>+20), hemisynanthropic (0-+20) or asynanthropic (<0) as explained above. The compositional similarity (as a measure of β diversity variation) expressed as ${}^{q}S$ for richness (${}^{0}D$) and dominant species (${}^{2}D$), were assessed within and among biomes and elevation categories respectively, follow the proposal of (Jost, 2007); ${}^{q}S=0$ when samples (biomes and elevation categories) compared are completely different, ${}^{q}S=1$ when samples are identical. When comparing couples of samples if $q=0$ (richness) then ${}^{0}S$ is equal to Jaccard index, and if $q=2$ then ${}^{2}S$ it is equal to Morisita-Horn index; these values were calculated by using SPADE online software (A. Chao, Ma, Hsieh, & Chiu, 2015). The altitudinal species distribution graphic were generated ranking the weighted average abundance of species by altitudinal range on using lattice package in R software (2013). Species reported here and a review of literature were used to build the updated checklist.

Results

A total of 3059 blow flies were collected, where 11 blow fly species recorded; eight are Calliphoridae (Six belonged to the subfamily Chrysomyiinae and two to Luciliinae) and three are Mesembrinellidae (Table 2). *Chrysomya albiceps* (38.7%) was the most abundant and common, followed by *Chrysomya megacephala* (24.2%) and *Mesembrinella umbrosa* (18.9%); the species *Lucilia purpurascens*; *Souzalopesiella fascialis* and *Hemilucilia segmentaria* were rare and scarce with less than 30 specimens collected (less than1%). *Paralucilia fulvinota* was found barely common in the SNSM.

The abundance of blow flies specimens collected by a single trap, varied from 17 blow flies (Locality N°5, sampling site N°19) to 436 blow flies (Locality N°3, sampling site N°8) and mean: 161 (131+/-SD) and absolute richness varied from 2 species (Locality N°5, sampling site N°19) to 8 species (Locality N°1, sampling site1 N°1 and 2); mean:4.4 spp (1.7+/-SD). The largest values of abundance observed coincided with dry lapses before and during the collection in the field. The number of individual catches based on Van Someren-Rydon fly trap was highly sensitive to rain, at least in the moist environments. Sampling coverage in each biome was higher or equal to 99%; in each altitudinal category was equal or higher to

98% and for all region was 99% indicating that collecting sites and the complete area were well sampled; and the observed data is trustworthy to make diversity comparisons in all orders of magnitude.

The highest values of diversity when q=0 was observed in the Montane wet forest biome, followed by the Premontane moist forest and the Tropical dry forest, the lowest value was observed in the urban area (Fig. 2). The same pattern was observed in the species accumulation curve, starting from a considerable low number of specimens (Fig. 3). Unlike of diversity values when q=1 and q=2 which the most diverse biome was the Premontane moist forest (Table 3). The $RLI_{0,2}$ ranking values were similar regarding to dominant species, the premontane moist forest showed the lowest inequality and the urban area the highest. The compositional similarity among the four biomes assessed was intermediate for the species occurrence (^0D=0.48) and low for dominant species (^2D=0.27). In all cases the compositional similarity was higher within the biome assessed than among biomes. In contrast for dominant species where the Premontane moist forest samples showed a lower value within this biome (^2D=0.19) than among the biomes. Comparing couples of biomes, the highest compositional similarity value was observed for the Premontane moist forest and the tropical dry forest (^0D=0.87) been the most resembles biomes in terms of species composition. In contrast the most different biomes were the Montane wet forest and the Urban area (^0D=0.16). Comparison for dominant species showed the highest value for the Montane wet forest (MwF) and the Premontane moist forest (PmF) (^2D=0.67) and the lowest for the Montane wet forest (MwF) and the Urban area (Urb) (^2D=0.001). It was clear the spatial segregation and tendencies of flies' abundances by related biome. All species of mesembrinellids and *L. purpuracens* showed strong preferences for the Montane wet forest. The species of *Hemilucilia* and *Paralucilia* were more associated with the Premontane moist forest, while *Co. macellaria*, *L. eximia* and *Ch. albiceps* were more related to the Tropical dry forest, as well as *Ch. megacephala* which was the dominant species in low lands including the urban area (Urb) (Fig. 4). In this survey the species *S. fascialis*, *M. patriciae* and *M. umbrosa* were exclusive of the montane wet forest, no other biome exclusivity were noticed.

Comparing by altitudinal range, the highest value of diversity when q=0 was observed in an intermediate altitude range 1.400-1.500 m.a.s.l.; similarly the intermediate range of the 1.500-1.600m showed the highest values of q=1and q=2. In contrast the lowest value of diversity when q=0 was observed in low lands (0-200m), regardless the vegetation or environment coverage. Although, the elevation range of 400-500m showed the lowest diversity values of q=1and q=2 (Table 3), the diversity values in all order of magnitude (^{0}D-^{2}D) tend to increase when approaching to intermediate altitudes (1.500-1.600m) (Fig. 5). The $RLI_{0,2}$ ranking values were similar regarding to dominant species, the elevation category N 8 (1.500-1.600m) showed the lowest inequality and the elevation category N 5 (400-500m) the highest (Table 3). The compositional similarity among altitudinal range, also was intermediate for species shared (^0D=0.45) and even lower for dominant species (^2D=0.26). The similarity of richness in all cases was higher within the altitudinal category than among categories; in contrast the similarity for dominant species were lower within the altitudinal category in 300-400m (^2D=0.23) and 700-800m (^2D=0.25) than among all altitudinal ranges (^2D=0.26). When comparing the similarity of shared species among altitudinal categories, some couple of ranges resulted identical (^0D=1) 1-2, 3-4, 3-5 and 4-5. For dominant species the highest value was observed among 6-7 altitudinal ranges (^2D=0.9). It is notable that the lowest values for dominant species (^2D=0) were; any of the first four altitudinal categories (N1, 2,3 and 4) compared with category N°8.

Based in this survey together with the previous records and bibliographic references a total number of 16 carrion-breeding blow fly species, distributed in 11 genera, 4 subfamilies and 2 families are reported in the complete area of the SNSM; four typical high elevation species and one rare (*H. benoisti*) were not collected in this study, but previously reported by Amat & Wolff (2007) and Amat (2009) and served to complete the list. For eleven species it was calculated the synanthropic index (S.I.), being three species classified as eusynantropic; two as hemisynanthropic and six asynanthropic (Table 2). Considering the information of the complete list; the Montante wet forest is also the richest biome while the páramo and the low land urban area are the poorest. Mesembrinellids are exclusive of montane wet forest; *B. splendens* are exclusive of the Montane rain forest and *H. benoisti* of Premontane moist

Forest. Finally *L. eximia* and *P. fulvinota* were the most generalist species in forest area while *Ch. albiceps* regardless the anthropic level of the environment was the most frequent (Fig. 6).

Discussion

Biome variation

The carrion-breeding blow fly species inhabiting the SNSM is remarkably rich and this is in complete agreement with the tropical Andes patterns. The greatest biological diversity in the Andean region is commonly found at mid elevation and foothills, and directly proportional to rainfall (Pyron & Wiens, 2013). Andes Mountains contains a remarkably variety of environments, where is possible to find a considerable variation of microclimates as a result of a complex interaction among topography and climate factors; these area host a large number of species; consequently the tropical Andes is being considered one of the most diverse “hotspot” on earth (Russell A Mittermeier, Turner, Larsen, Brooks, & Gascon, 2011). All of these characteristics are present in the SNSM, where the variety of biomes, not only support the carrion-flies diversity but a high diverse fauna and flora. The highest values of diversity (q=0) observed at in the Montane wet forest at mid-elevation corroborates the tendencies above stated (Fig. 2); and also the results of Baumgartner & Greenberg (1985) in a rather similar transect in the eastern slope of the Peruvian Andes during three years of survey, where the highest number of carrion flies were found in the range of 1000-2000 m a. s. l. and more specifically at 1600m a. s. l. We may foresee that the high rate of biological diversity in the montane forest may provide more offer of resources, food, shelter, dung availability, number and type of carcasses, and enhance ecological relationships for carrion-flies, than the others biomes along the altitudinal gradient. The lowest values of diversity (q=0) were recorded in the urban area; this corroborate that urbanization and human activities strongly alters land surfaces, habitat structure, and ecological function well beyond the boundaries of the urban area (Grimm *et al.* 2015). Has been proven that this often promotes the persistence of exotic species (Kavazos & Wallman 2012) as we evidenced for the case of *Chrysomya* species in the SNSM. The less showed differences on relative abundance (particularly among *Ch. albiceps*, *M umbrosa* and *H. semidiaphana*) and dominance in the premontane moist forest may explain the highest values of the diversity when q=1, 2 an the less degree of inequality ($RLI_{0,2=}0.45$). In contrast to the Montane wet forest where *M. umbrosa* was significantly dominant. Since bionomics and ecology of mesembrinellids are poorly understood, we prefer do not explain its dominance or address any discussion about population aspects. Lowest values of this diversity magnitude order q=2 were similarly observed in the urban area regarding the highest inequality ($RLI_{0,2=}0.67$) where the exotic species of *Chrysomya* were remarkably abundant and dominant; again corroborating the appalling effects of urbanization mentioned above. The tropical dry forest shows an intermediate level of carrion-breeding blow flies' diversity (Table 3); as the rest of the forest biomes here assessed, despite this it host an endemic component of the fly fauna. The colonization of the premontane moist forest by typical lowland species *Ch. albiceps*, *Ch. megacephala*, *Co. macellaria* and *L. eximia* and their spatial adjacency explain the highest compositional similarity among the tropical dry forest and the premontane moist forest (Table 4). These species seem to ascent the gradient easier than the typical montane species to get down. By the other hand, the less similarity (${}^{0}D$, ${}^{2}D$) among the montane wet forest and the urban area was due to their origins and the spatial isolation. For the case of the dominant species probably the high capacity of the dispersal of the *Ch. albiceps* and *L. eximia* and together with the low number of specimens found respectively. The highest value of compositional similarity of dominant species (${}^{2}D$) among the montane wet forest and the premontane moist forest was due to the remarkable abundance of *M. umbrosa*. All species of Mesembrinellidae were asynanthropic and exclusive of the undisturbed Montane wet forest; the occurrence of this taxa in Andean environments may serve as a preliminary ecological indicator of undisturbed forest.

Altitudinal variation

As we pointed above the vertical occurrence of the biomes in the Andes is depending of the climatic component, but the topography and the edaphic conditions may affect (Cleef *et al.*, 1984; Van der Hammen, 1984); in the SNSM this is not the exception. The climate here change dramatically along the altitudinal gradient (Table 1); since the altitudinal range was highly concordant with the biomes distribution. As evidenced in the case of biome variation, the vertical distribution and segregation of species by altitudinal range was also confirmed; all magnitude orders of diversity (q=0,1,2) tended to increase when approach to an intermediate altitude range (Fig. 5), which corroborates the results of Baumgartner and Greenberg (1985) above mentioned, and inversely proportional to the degree of inequality of dominant species (RLI_2). Correspondences among the altitudinal ranges and biomes values were evident in category N7 (1.400-1.500m) which agrees with the montane wet forest, category N6 (700-800m) with the premontane moist forest and category N 4 (300-400m) with the Tropical dry forest (Fig. 4); this led us to consider that possible differences in diversity trends (structure and composition) according the altitudinal range were not clearly evidenced because they are acting as the same unit of comparison (with the biomes). For this reason the blow fly assemblage here assessed, was probably more related to the biome type than to the altitudinal range. To evaluate the effect of altitude over the composition assemblage is more reasonable to compare similar anthropized environments or biomes at different altitude ranges. These similar environments are inexistent in the SNSM but more than likely along the Andean chain. This was partially evidenced if considering the contrasting values of q=1,2 among N3 and N4 altitudes, together belong to a Tropical dry forest but higher diversity was evidenced in the altitude category above (N4). Anthropization effects also were partially evidenced if considering the differences in the values of q=0,1,2 among N1 and N3 altitudes, together belong originally to a Tropical dry forest, but less diverse in the anthropized urban area. Based on the similarities values among low land altitudinal categories and the highest locality in this survey (Intermediate elevation) we suggest categories ranging each 500m to asses altitudinal gradient within the Andean cordilleras.

Faunal composition and synanthropy

The origin of Andean insects taxa had been hypothesized by vertical and horizontal colonization; in principally four different geographical mechanisms of speciation: 1) colonization from temperate latitudes; 2) speciation across elevational gradients; 3) radiation within the Andes; and 4) allopatric speciation between the Andes and other adjacent montane regions. There is evidence in butterflies and dung beetles that vertical or elevational colonization is more significant and frequent in the current compositional fauna (Escobar, Lobo, & Halffter, 2006; Willmott, Hall, & Lamas, 2001). None phylogeographical study with carrion-breeding flies had test the configuration of the current Andean fauna; even though some approximations were mentioned for the Páramo carrion-breeding blow fly fauna (Amat *et al.*, In press). Here at least five geographical components or distributional patterns not phylogenetic related (except *Chrysomya* spp for introduced species and Toxotarsinae species for high elevations) were evidenced; according their altitudinal distribution and possibly to their origin; they are:

(1) Lowland species: *Cochliomyia macellaria* was the only neotropical species with this spatial distribution in the SNSM; and common species of the Tropical dry forest (TdF) (Fig. 4). This is a widespread species in the new world. Before the introduction of *Chrysomya* spp., it used to be a dominant species at coastal environments at the sea level (Baumgartner & Greenberg, 1985), as probably was in the SNSM. Here we corroborate its eusynanthropic tendency (S.I.=69). It is a very common species of medical and forensics importance.

(2) Introduced species: they are the exotic species of *Chrysomya* that were introduced decades ago and then widely spread in neotropical environments: *Ch. megacephala*; abundant and eusynanthropic species (S.I.=98) in the area of Santa Marta town were dominant and colonizing anthropized environments of the foothills of the SNSM as in the rest of the northern Andean region (Amat, 2009). *Ch. albiceps* a eurythermal species in the Andes; very frequent species in all ridges at median elevation in Colombia (Wolff & Kosmann, 2016). In the SNSM reach the premontane moist forest (PmF), but it was dominant in the range of 300-400m (Fig. 4) with eusynanthropic tendencies (S.I=59); this is also a fly of medical and forensic importance. These two species were the most abundant of the complete survey (62%), hence we believe that after its introduction in the seventies they radically changed ecological aspects of the local carrion-breeding flies communities and its interactions. The competition, aggregation and coexistence; diversity-function relationship among other ecological issues would be studied in the Andes in order to describe the real effects of these exotic taxa in montane enviroments.

(3) Foot hill species: species of *Hemilucilia*; *Paralucilia* and the *L. eximia* are part of this component. In the Andes *H. segmentaria* occurs at lower altitudinal distribution than *H. semidiaphana* (Amat, 2009; Wolff & Kosmann, 2016); unusually in the SNSM this was not the case and both occurs more related to the premontane moist forest (PmF), and more abundant in the range of 700-800m, being *H. segmentaria* remarkably scarce with

asynanthropic habits (S.I= -100). While *H semidiaphana* behaved as hemisinantropic (S.I=20). *H. benoisti* which was recorded in the SNSM by Amat (2009) based in a single female and identified erroneously as *H. townsendi*. We could corroborate this record based in a male specimen cleared and dissected, it also were collected in the same locality with this label data: "Colombia, Magdalena, Santa Marta, C. Tigrera, cuenca del Rio Gaira. 11.163060 °N, -74.171051°W. 29.vi.2004. Trampa excremento humano T56. Leg Ospino D and Garcia H" and deposited at the entomological collection of the Instituto Alexander Von Humboldt (IAvH-E). This is an uncommon species associated exclusively to the Premontane moist forest; it seem to be more attracted to human feces than the animal carcasses. *Paralucilia fulvinota*. shows asynanthropic habits (S.I=-79), it was more related to the undisturbed premontane moist forest and the montane wet forest in the range of the 700-800 m. *L. eximia* a widespread neotropical species showed a premontane tendency as in the Peruvian Andes (Baumgartner & Greenberg, 1985), in the SNSM it was abundant at the 300-400m range, being eusynanthropic (S.I=48); corroborating this tendency to human population already studied in the Colombian central range (Montoya-G *et al.*, 2009). its Andean distribution must be carefully reviewed since previous to the taxonomical review of Whitworth (2014) many specimens of allied species were misidentified as *L. eximia*. All taxa here grouped have precedents of low land distribution in other biogeographical region in South America; this led us to think a relative ease to colonize foothills environments.

(4) Montane species: All species of mesembrinellids occurs in this environment, which specimens were of mid-elevation distribution and close related to the undisturbed Montane wet forest, being remarkably asynanthropic (S.I= -100). *S. fascialis* and *M. umbrosa* primarily with trans-Andean distribution and lately recorded in the Colombian Andes (Wolff & Kosmann, 2016) together are poorly known species. and *M. patriciae* of Andean typical distribution along all ranges in Colombia; reaching the 2500m of elevation (Wolff, 2013). *B. splendens* which is endemic to the Andean undisturbed montane forest may reach the 2600m; in the SNSM seems to be an exclusive species of the montane rain forest and it was registered at 2500m by Amat and Wolff (2007) collected from a Malaise Trap. *L. purpuracens* a neotropical species of wide montane distribution, it is an uncommon fly in Peru but occurs in the range of 1900m (Baumgartner & Greenberg, 1985); although in Colombia it is more

frequent above 2000 m (Wolff & Kosmann, 2016); in the SNSM it was a asynanthropic species related to the montane wet forest at an intermediate altitude range (1400-1500m). And finally *C. verena*, a typical montane species that ranges in altitude from 1200-3000m in Colombia and Peru (Baumgartner and Greenberg, 1985; Amat, 2009), it is of forensic and medical importance, especially in urban environments (N A Segura, Bonilla, Usaquén, & Bello, 2011); recently it was registered as hemysinanthropic reaching the páramo environment in the central range of Colombia and Ecuador (Amat, Perez-Hoyos & Alvarez in press). This category groups the well stablished montane species, not only distributed in the Andes range but in some other Neotropical mountains e.g. Central cordillera of Costa Rica and Venezuelan tepuis among others.

(5) High elevation species: two species of the subfamily Toxotarsinae were recorded in the SNSM above the 2500m (Amat, 2009); based on these and the latest geographical records in the high altitude Andean Páramos (Amat, Perez-Hoyos & Alvarez in press); we anticipate that these species prevail at this elevation range. *Sarconesia roraima* a high altitude Andean endemic species that is distributed from Bolivia to Venezuela (Dear, 1985) was reported as an asynanthropic fly, that is highly abundant in the forest and rural areas during the rainy season in the surrounding montane areas of Bogotá, Colombia (Pinilla-Beltran, Segura, & Bello, 2012); it seems to be uncommon in the SNSM but more collection effort is desire. And finally *S. magellanica* widely distributed from Chile to Colombia up to an elevation of 3250 m (Dear 1979). In Peru, it was recorded as eusynanthropic ranging from 1800 to 4000 m on both Andean slopes (Baumgartner & Greenberg 1985). In Colombia, this species seems to be common on every ridges (oriental, central, and occidental) from above 1800 m to 3100 m (Amat 2009), and hemisynanthropic in the outskirts of Bogotá (Pinilla-Beltran *et al.* 2012). This species is reported of forensic importance for being an active carcass colonizer in high elevations (Segura *et al.* 2011). The biology of this species, including its lifecycle and populational parameters in the laboratory, were studied by Pinilla *et al.* (2013).

The diversity of carrion-feeding blow flies found in the SNSM may be explained based on two kind of interpretations for global diversity gradients. The ecological hypothesis and the evolutionary and historical hypothesis (Mittelbach *et al.*, 2007), probably acting together at different magnitudes. The ecological interpretation encompasses the spatial or environmental heterogeneity hypothesis (Pianka, 1966), the disturbance hypothesis (Connell, 1978) and the altitudinal gradient richness hypothesis (Rahbek, 1995). The first is evidenced as the result of all the biomes combination in the SNSM above discussed. The second is related with the anthropization process (urbanization) as the disturbance promote, more evident in the diversity data observed in the Tropical dry forest and the urban area of Santa Marta town. Moreover, the altitudinal gradient, which had been extendedly studied, and here in the SNSM with a hump-shaped expected distribution, may be supported by a variety of hypothesis to explain this unusual altitudinal pattern. They are primarily based on the water availability, ecosystem productivity and soil condition, which usually peaks at intermediate elevation (Rahbek, 1995). These peaks are clearly observed in the mid-elevation environments at SNSM.

The evolutionary and historical hypothesis encompasses more complicated processes, difficult to approach under short-term assessments. However, they are worth mentioned; the Time and Area hypothesis which claims that communities tend to diversify in time. Thus, ancient areas hosting old communities has more diversity that the recent ones. This hypothesis may be considered here in two scales; the asynchronic uplift of the SNSM (65 to 8 MYA) compared with the three Andean cordilleras (Tschanz *et al.*, 1974). And the specific local scale, that support the idea that higher altitudes in a mountain environment sustenance younger ecosystems; this may explain the poor diversity of the Páramo as reported by Amat *et al.*, (2017). And finally, the area hypothesis, based in the insular biogeography theory (MacArthur & Wilson, 1967), which in a sketchy sense, count the size of island as one of the key factor influencing the richness. Thus, a larger area usually facilitates greater diversity. Incompatible if considered at a regional scale, where the carrion-breeding blow fly fauna (Table 2) found in the relatively small area comprised of the SNSM (17000km2); is the 98% of the genera, and 50% the species of the complete Colombian Andes region, recorded by Wolff & Kosmann (2016). But compatible at local scale if compare the effective area of Páramo on the top of the SNSM with the rest of the evergreen area. The latest is relating to a decrease in diversity with increasing elevation to the complete reduction in available area from the base to the top of mountains (Rosenzweig, 1995). Some other biogeographical hypothesis driven the assemblage of the current fauna must be studied under the phylogeography framework and were mentioned at the beginning of the faunal composition paragraph. The results presented point that the spatial and biomes heterogeneity found in the SNSM is the key factor to explain the current diversity of carrion-breeding blow flies in the SNSM.

Recent studies in the Andean region suggest that a punctual in time assessment of carrion-fly assemblage may drastically underestimate the fauna when compared with a one year sampling study or longer (Ramirez-Mora et al 2012); thus the analysis of the diversity patterns here exposed must be interpreted with caution for applied purposes, even if statistically observed diversity reach the expected. The seasonal ecological patterns were not considered here nor the complete altitudinal gradient, where it is expected to find a decrease tendency of all order of diversity (q=0,1 and 2) above 2000 m. In order to evaluate ecological patterns of the Andean carrion-feeding blow flies, for their use in conservational, medical and the forensic context a long-term program monitoring and an intensive data collection in different levels of anthropization preferably at 500m ranges is strongly recommended. As well as biogeographic and phylogeographic studies to understand the neotropical blow fly fauna origin and speciation processes across altitudinal and latitudinal gradients.

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Table 1. Geographical, ecological regionalization and climatic information of sampling localities; m.a.s.l: meters above the sea level, mm: millimeters.

Number of the locality	Locality	N° Traps (number of sampling site)	Biome (Anthropic category)	Altitude (m.a.s.l) and elevation Category	Coordinates	avg. annual Precipitation (mm)	avg. annual Temperature (°C)
1	Cincinati	4 (1-4)	Montane wet forest (Wild)	1427-1600; 7,8	11° 5'43.3"N - 74°4'36.7"W	2730	15
2	Minca	3 (5-7)	Premontane moist forest	465-770; 5,6	11° 8'34.2"N - 74° 6'31.5"W	2298	22
3	Bonda	4 (8-11)	Tropical Dry forest (Rural)	250-388, 3,4	11°14'54.5"N - 74° 4'3.0"W	1100	26
4	Palangana	4 (12-15)	Tropical Dry forest	140-200; 2	11°16'14.4"N - 74° 9'24.3"W	800	25
5	Santa Marta	4 (16-19)	Urban (Urban)	20-30; 1	11°13'19.7"N - 74°11'12.2"W	658	29

Table 2. Updated checklist of carrion-breeding blow flies species of the Sierra Nevada de Santa Marta; biome preferences, Synanthropic index and altitudinal distribution. (MrF): Montane rain forest; (MwF) Montane wet Forest; (Par): Páramo; (PmF): Premontane moist forest; (TdF) Tropical dry forest; (Urb): Urban; (as) asynanthropic; (eu) eusynanthropic; (hem) hemisynanthropic; (m) meters above sea level.

Family	Subfamily	Species	Biome	S.I	Altitudinal range (m)	Reference
Calliphoridae	Luciliinae	*Blepharicnema splendens* Macquart, 1843	MrF	-	2500	Amat & Wolff 2007
		Lucilia eximia (Wiedemann, 1819)	MwF, PmF, TdF	48(hem)	140-1430	
		Lucilia purpurascens (Robineau-Desvoidy, 1830)	MwF	-100(as)	1420-1600	
	Chrysomyiinae	*Chrysomya albiceps* (Wiedemann, 1819)	Urb, TdF, PmF	59(eu)	0-1420	
		Chrysomya megacephala (Fabricius, 1794)	Urb, TdF	98 (eu)	0-460	
		Compsomyiops verena (Walker, 1849)	MrF, Par	-	2500	
		Cochliomyia macellaria (Fabricius, 1775)	Urb, TfF	69 (eu)	0-460	
		Hemilucilia benoisti Séguy, 1925	PmF	-	740	Amat 2009 (as *H. townsendi*)
		Hemilucilia segmentaria (Fabricius, 1805)	PmF, MwF	-100 (as)	700-1500	
		Hemilucilia semidiaphana (Rondani,1850)	TdF, PmF	20 (hem)	260-1430	Amat 2009
		Paralucilia fulvinota (Bigot, 1877)	TdF, PmF, MwF	-79 (as)	260-1570	
	Toxotarsinae	*Sarconesia magellanica* (Le Guillou, 1842)	MrF, Par		2500	Amat 2009
		Sarconesia roraima Townsend, 1935	MrF	-	2100-2800	Amat 2009
Mesembrinellidae	Mesembrinellinae	*Mesembrinella patriciae* Wolff, 2013	MwF	-100 (as)	≥1420-?	
		Mesembrinella umbrosa Aldrich, 1922	MwF	-100 (as)	≥1420-?	
		Souzalopesiella fascialis (Aldrich, 1922)	MwF	-100 (as)	≥1420-?	

Table 3. Species data diversity for each biome, environment and elevation range. Nt= number of traps VSR, Ni = number of specimens. $\hat{C}$n=sample coverage percentage. Observed and Expected values of Hills numbers; ^{n}D diversity values of order *q*=n. $RLI_{0,2}$= relative logarithmic inequality.

N° of Loc (category of elevation)	**Biome – Environment - Elevation range**	N_t	N_i	$\hat{C}_{m\ (\%)}$	**Obs.**			**Exp.**			$RLI_{0,2}$
					^{0}D	^{1}D	^{2}D	^{0}D	^{1}D	^{2}D	
1	Montane wet forest (MwF)	4	524	99	9	3.3	2.3	9.9	3.3	2.3	0.62
2	Premontane moist forest (PmF)	3	633	99	8	3.74	3.13	8.9	3.77	3.15	0.45
3,4	Tropical dry forest (TdF)	8	1150	100	6	2.67	1.93	6	2.67	1.93	0.63
5	Urban (Urb)	4	752	99	4	1.89	1.57	4	1.89	1.57	0.67
(1)	0-100	4	752	99	4	1.89	1.57	4	1.89	1.57	0.67
(2)	100-200	4	354	99	4	2.53	2.31	4	2.53	2.31	0.40
(3)	200-300	1	271	99	6	1.79	1.36	6.9	1.82	1.36	0.83
(4)	300-400	3	525	100	6	2.21	1.61	6	2.41	1.74	0.73
(5)	400-500	1	213	98	6	1.47	1.18	8.9	1.50	1.19	0.91
(6)	700-800	2	420	100	6	3.49	2.61	6	3.51	2.62	0.46
(7)	1400-1500	2	443	99	9	3.03	2.03	9.9	3.07	2.03	0.68
(8)	1500-1600	2	81	100	5	3.94	3.38	5	4	3.48	0.24
-	Complete área	19	3059	99	11	5.38	4	11	5.38	4	0.42

Table 4. Compositional similarity *CS* of richness (^{0}D) and dominant species (^{2}D) of carrion-breeding blow flies according biomes and altitudinal categories in the Sierra Nevada de Santa Marta. (MrF): Montane rain forest; (MwF) Montane wet Forest; (Par): Páramo; (PmF): Premontane moist forest; (TdF) Tropical dry forest; (Urb): Urban.(m): Meters above sea level.

Compositional similarity	^{0}D	^{2}D
Within Biome type		
MwF	0.55	0.45
PmF	0.56	0.19
TdF	0.59	0.41
Urb	0.66	0.53
Among Biome type		
All biomes	0.48	0.27
MwF-PmF	0.58	0.67
MwF-TdF	0.45	0.005
MwF-Urb	0.16	0.001
PmF-TdF	0.87	0.63
PmF-Urb	0.62	0.15
TdF-Urb	0.66	0.52
Within Elevation category		
1 (0-100m)	0.66	0.53
2 (100-200m)	0.59	0.41
3 (200-300m)	-	-
4 (300-400m)	0.5	0.23
5 (400-500m)	-	-
6 (700-800m)	0.83	0.25
7 (1400-1500m)	0.77	0.95
8 (1500-1600m)	0.6	0.52
Among Elevation Category		
All elevation categories	0.45	0.26
1 -2	1	0.52
1 - 3	0.57	0.16
1 - 4	0.66	0.25
1 - 5	0.44	0.14
1 - 6	0.25	0.02
1 - 7	0.16	0.001
1 - 8	0	0
2 - 3	0.57	0.79
2 - 4	0.66	0.7

2 - 5	0.44	0.78
2 - 6	0.25	0.12
2 - 7	0.167	0.003
2 - 8	0	0
3 - 4	1	0.86
3 - 5	1	0.98
3 - 6	0.45	0.16
3 - 7	0.41	0.004
3 - 8	0.09	0
4 - 5	1	0.77
4 - 6	0.5	0.15
4 - 7	0.45	0.007
4 - 8	0.1	0
5 - 6	0.36	0.21
5 - 7	0.35	0.04
5 - 8	0.16	0.013
6 - 7	0.77	0.9
6 - 8	0.22	0.18
7 - 8	0.5	0.21

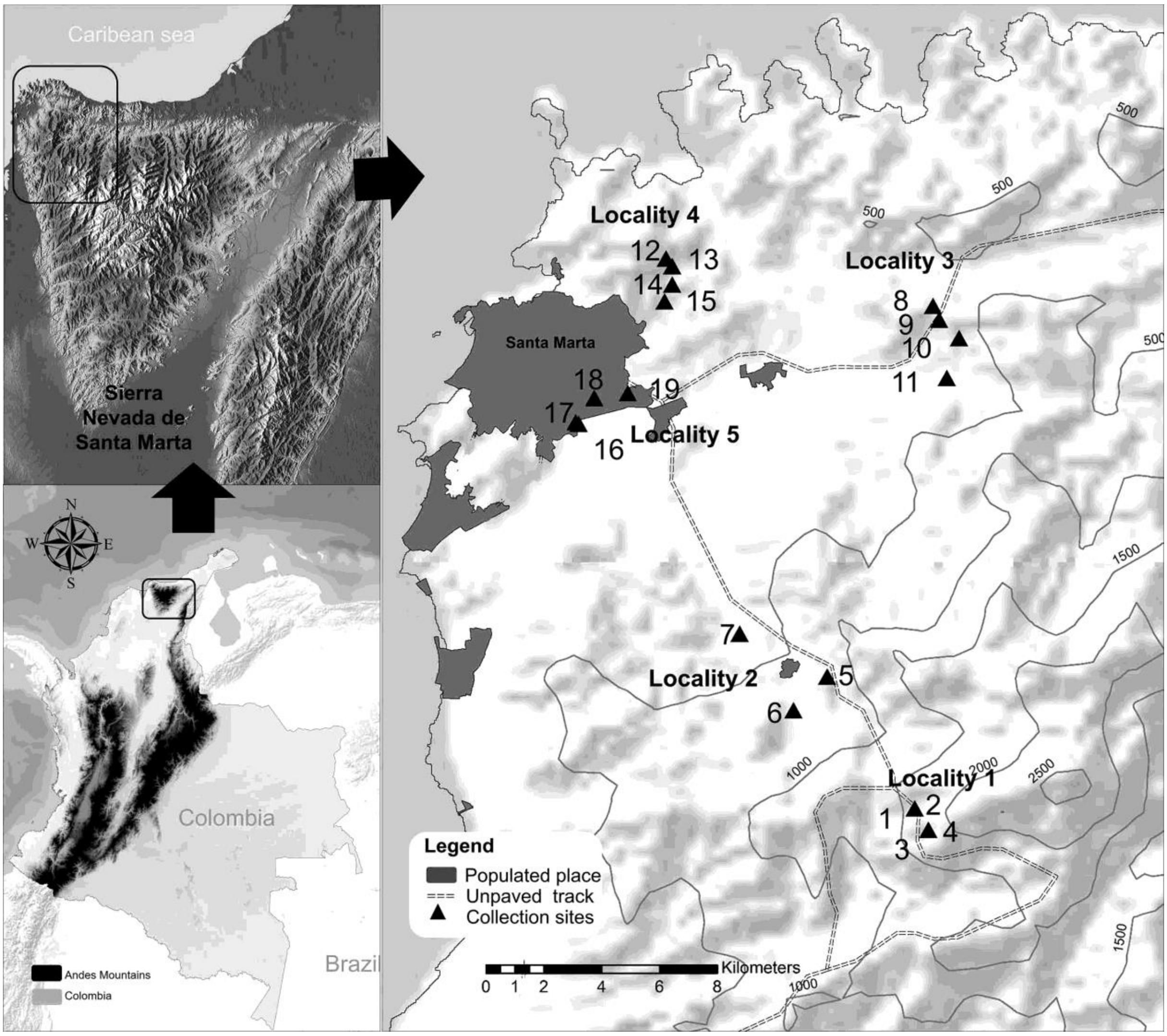

Fig. 1. The geographical location of the sampling localities and collection sites in the Sierra Nevada de Santa Marta, Colombia.

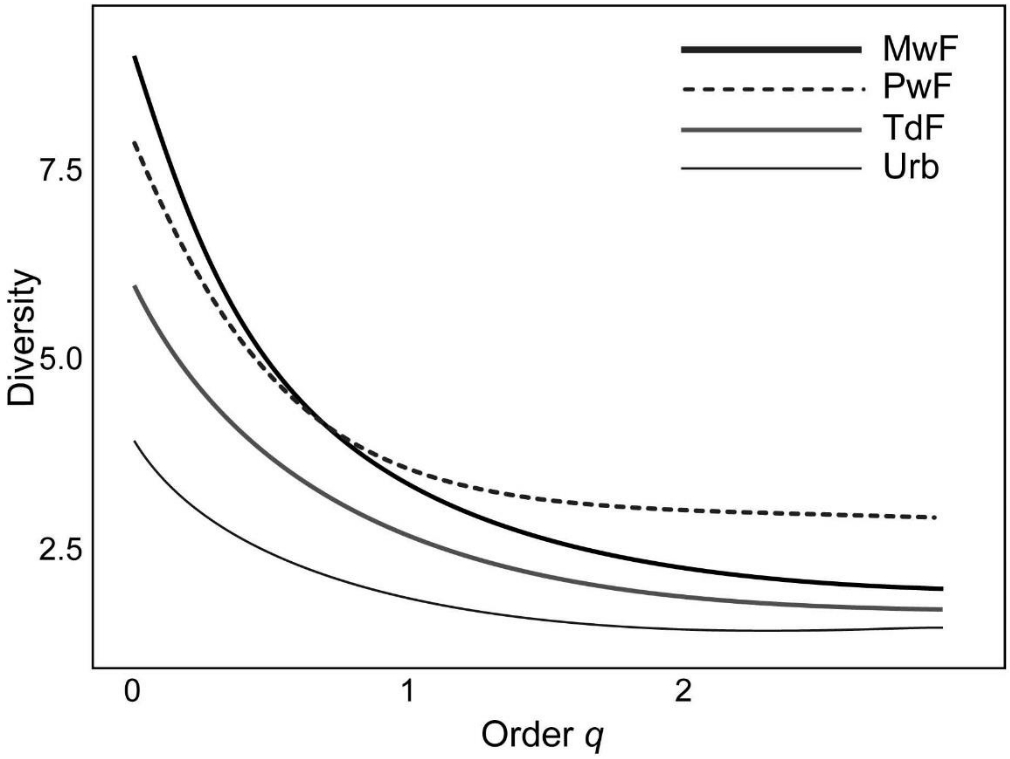

Fig. 2. The diversity profile observed based in the effective number of species (q=0,1,and 2) of the carrion-breeding blow flies species by biome assessed in the Sierra Nevada de Santa Marta. MwF: Montane wet forest; PmF Premontane moist forest; TdF: Tropical dry forest; Urb: Urban area.

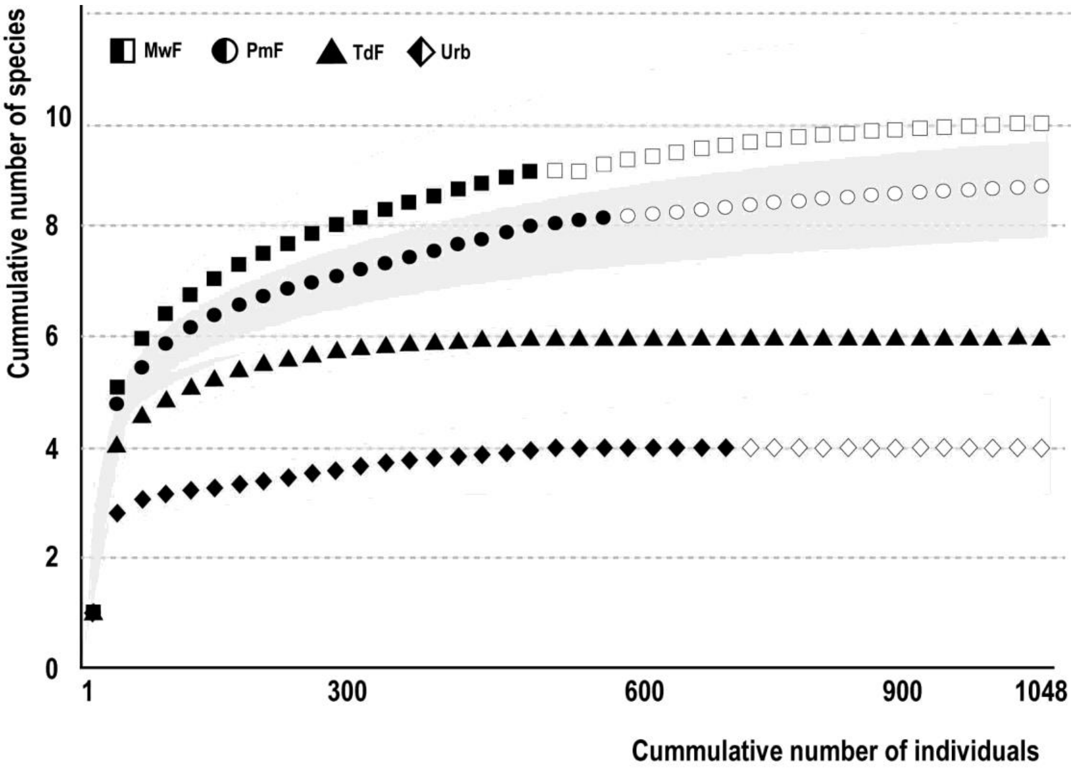

Fig. 3. Carrion-breeding blow flies species accumulation curves by environment assessed. MwF: Montane wet forest; PmF Premontane moist forest; TdF: Tropical dry forest; Urb: Urban. Black marker is based interpolated data; white marker is based extrapolated data, shade area: CI=95%

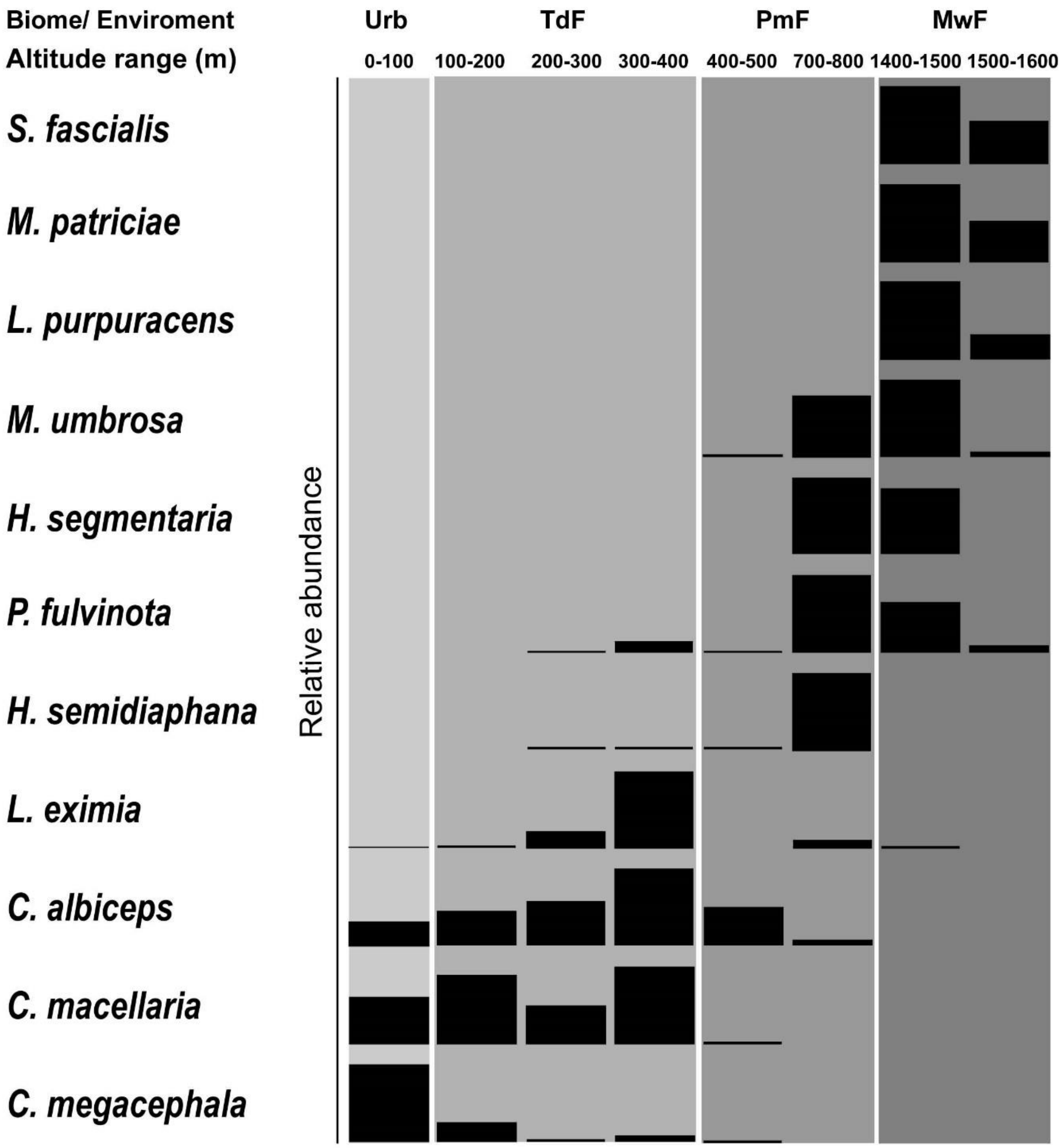

Fig. 4. Vertical distribution and tendencies of the carrion-breeding blow flies according the relative abundance by biome and altitudinal range.

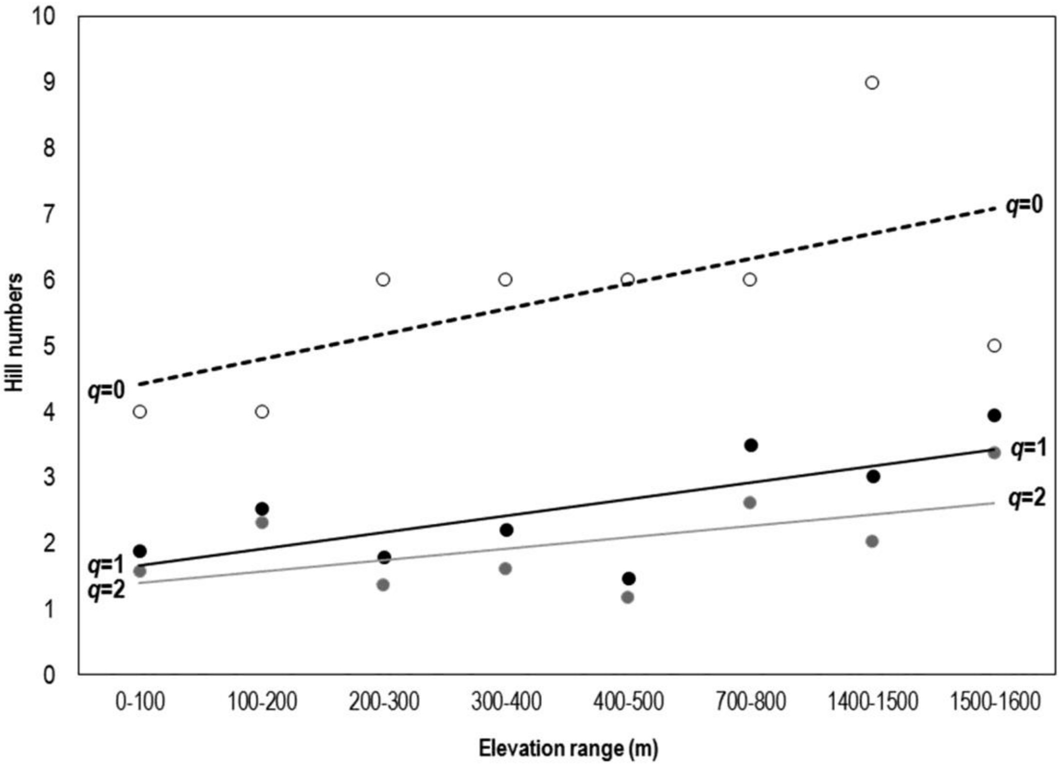

Fig. 5. Linear function of species diversity based on the effective number of species (q=0, 1 and 2) of carrion-breeding blow flies species by altitudinal ranges in the Sierra Nevada de Santa Marta.

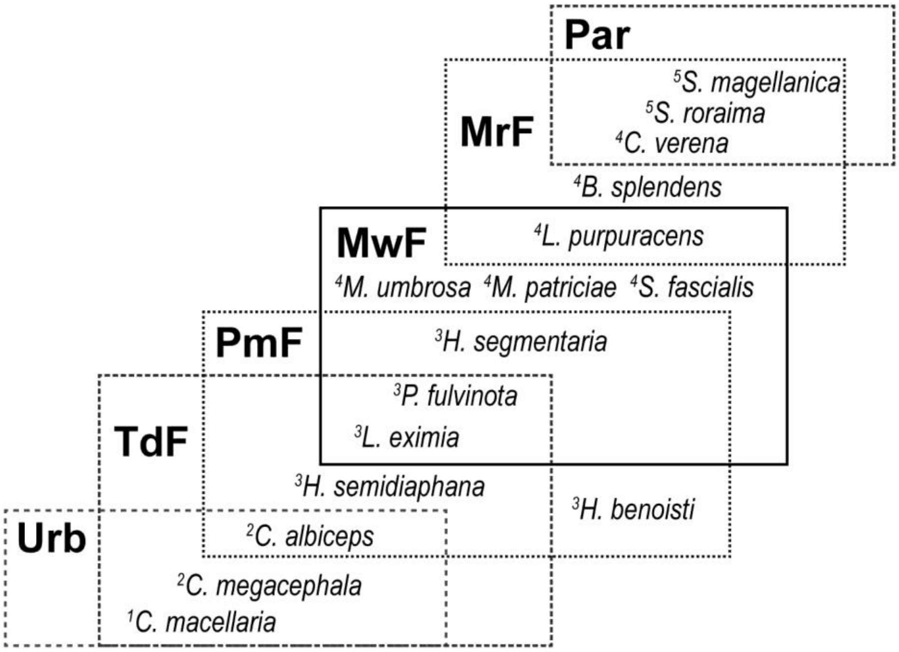

Fig. 6. Occurrence of the carrion-breeding blow flies species by biome and by group of distributional altitude; (MrF): Montane rain forest; (MwF) Montane wet Forest; (Par): Páramo; (PmF): Premontane moist forest; (TdF) Tropical dry forest; (Urb): Urban. 1 lowland species; 2 Introduced species; 3 Foothill species; 4 Montane species; 5 High elevation species.

Capítulo 3

Amat, E. Perez-Hoyos, A. Alvarez-Hincapie, F. Moreno, E & Barragan, A. Submitted. A two-year survey of Carrion-Breeding Blow flies (Diptera, Calliphoridae) diversity from the Páramo de Belmira in the Northern Andes. *Revista de Biología Tropical.*

A two-year survey of Carrion-Breeding Blow flies (Diptera, Calliphoridae) diversity from the Páramo de Belmira in the Northern Andes

Eduardo Amat[1,2*]; Adriana Pérez-Hoyos[2], Carlos Alvarez-Hincapie[3], Emília Moreno[4] & Álvaro Barragan[4]
[1] Instituto Nacional de Pesquisas da Amazônia – INPA, Programa de Pós-graduação, Coordenação de Biodiversidade - CBIO, Manaus, Amazonas, Brazil; ecamat@gmail.com

[2] Grupo de Investigación Ciencias Forenses y Salud (GICFS), Tecnológico de Antioquia Institución Universitaria. Medellín, Colombia; adriperez06@gmail.com

[3] Grupo de Investigación en Sistemática Molecular, Universidad Nacional de Colombia sede Medellín. Medellín, Colombia; cfalvare@gmail.com

[4] Museo de Zoología, Sección Invertebrados (QCAZ-I), Laboratorio de Entomología, Escuela de Ciencias Biológicas, Pontificia Universidad Católica del Ecuador, Quito, Ecuador; emiliamorenoc@gmail.com; arbarragan@gmail.com

*Correspondence

Abstract: The diversity of the carrion-breeding blow flies (Diptera: Calliphoridae) was studied in a two-year survey along an anthropized gradient of localities within the area of Belmira Páramo (in the central Andean ridge of Colombia). An annotated checklist of species found in the South American páramos is also presented. Species richness in the Belmira páramo's assemblages is remarkably low, in contrast with the high level of dominance. A progressive reduction in the values of the three orders of diversity (0,1,2D) was observed when approaching the human settlement. No temporal seasonality was noticed regarding species abundance. A brief discussion about the use of blow flies as an indicator of anthropization processes and the biogeographical components of the fauna in the páramo is offered. We documented the highest elevation record of the introduced Chrysomya genus at this latitude of >3 000 meters high. This study aims to provide basic biological data of species and blow flies assemblages for further conservational, ecological, and forensic studies in the Paramo ecosystem.

Key words: Andes, *Chrysomya*, diversity, forensic entomology, Hill numbers

Total word: 9068

The páramo is a unique, high-altitude ecosystem in the Andean mountain range that covers an area from the upper part of the Andean forest line (an approximate altitude of 3000 m) to the permanent snow line (an approximate altitude of 5 000 m). Páramos can be found in southern Ecuador, Colombia, and western Venezuela (CAN, 2009). Similar ecosystems (jalca) exist in northern Peru, as well as a small complex in Costa Rica, but the flora is different. The páramo physiognomy is comprised of heterogeneous grasslands mixed with shrubby patches of a unique tropical flora; approximately 86% of the angiosperms are endemic of this ecosystem (Londoño *et al.* 2014). The páramo has an invaluable economic and ecologic importance, and is the major provider of good quality water for human use at this latitude (Buytaert *et al.* 2006). Like the rest of the mountain ecosystems, the páramo is highly vulnerable to the effects of global climate change, as well as to the increase of human activities such as potato farming, livestock grazing, soil burn and fire, exotic plantations' development, and tourism, all of which dramatically affect the hydrological balance (Buytaert *et al.* 2006; CAN 2009; Van der Hammen *et al.* 2002). Colombia has the largest area of páramo (14 047 km^2), followed by Ecuador (13 933 km^2). It is estimated that in a future scenario with twice the amount of CO_2 and an increase of 2.5–3°C in temperature, 55.45% of the current páramo area could be affected and the displacement of its area might reach 44.8% (Castaño 2002). endangering the paramo´s endemic fauna which could reach 60% of the living oranisms (Van der Hammen *et al.* 2002). The páramo encompasses a unique particular set of fauna and flora, and is thus a hotspot of endangered and undiscovered biodiversity (Myers *et al.* 2000).

The arthropods inhabiting the páramo ecosystem are poorly studied or unknown. It is possible many species still remain undescribed, and as in other environments they may play an important role as bioindicators of high montane ecological processes (Van der Hammen *et al.* 2002). Only a few studies are available in the related literature: initial studies including taxa checklists and microhabitats preferences (Amat-García 1991; Amat-Garcia & Vargas 1991; Sturm 1978); diversity of the soil fauna (Morales & Sarmiento 2002; Salamanca & Chamorro 1994; Van der Hammen 1984) and recent studies about the diversity of aquatic macroinvertebrates (Posada-García *et al.* 2008). A well-documented compilation about the historical entomological research focused on Ecuadorian fauna is detailed in the monograph by Moret (2005). Some other studies that are noteworthy deal with the tolerances and adaptations of insects to low temperatures (Sømme 1986; Sømme *et al.* 1996), butterfly diversity (Adams 1986, Pyrcz *et al.* 2016), and the taxonomy and biogeography of the Ecuadorian carabid beetles (Moret 2005). One recent study demonstrated that in the last three decades, changes in carabid beetles' assemblages, geographical distribution, and altitudinal limits in high-elevation habitats were evidenced due to global warming effects (Moret *et al.* 2016). Only one study reported on carrion-breeding insects in the páramo (Martinez *et al.* 2007), and no known studies have focused on carrion-breeding blow flies.

In the same way that páramo insects are little known, some ecological processes, such as organic matter decomposition dynamics, remain unexplored (Hofstede *et al.* 2003). In the páramo, as in any other environment, the decomposition process is essential for nutrient cycling within the ecosystem. In this ecological process, the fungi, bacteria, and arthropods play important roles. For this reason, carrion-breeding blow flies, as one of the most conspicuous and active macro-organisms that reduce organic matter is ecologically fundamental (Anderson & Cervanka 2002; Norris 1965; Nuorteva 1977), and would be a key component to the study and understanding of the biological decomposition and ecological dynamics of this fragile ecosystem. Besides their ecological significance, some species of carrion-breeding blow flies (Diptera: Calliphoridae) are also of medical and sanitary importance. Due to their active flight patterns, they can alternate between feces and comestibles, and it has been proven that flies play an important role as mechanical vector, transmitting pathogens and causing enteric diseases (Greenberg 1971; Cadavid-Sanchez *et al.* 2015). On the other hand, blow flies were used by ancient cultures for therapeutic treatment of serious or chronic wounds; this technique is now known as larval therapy, biotherapy, or biosurgery (Sherman 2003). Additionally, these flies are the most important insects commonly used in the forensic entomology framework, as their biology—including the lifecycle parameters and the larval stages' durations—are essential for calculating the Post-Mortem Interval (PMI), which is the time that elapsed between death and the corpse's discovery (Amendt *et al.* 2004). In countries like Colombia, the use of carrion-breeding blow flies as medico-legal evidence for legal purposes has increased in the last decade (Amat & Gomez-Piñerez 2012), as nearly 20% of homicides take place in rural areas (De la hoz 2013), where there is a frequent occurrence of corpses in distant and isolated locations placed near or within the páramo area.

The spatial distribution and chorological patterns of these flies are strongly affected by the degree of human impact on the natural environment (the anthropization process); this is commonly known in the entomological frame of reference as "synanthropy" (Gregor & Povolný 1958). Synanthropic, hemisynanthropic, and asynanthropic are the ecological categories for classifying flies according to their degree of attraction or repulsion for human settlements (Greenberg 1971). In recent years, studies on the responses in assemblage composition of the carrion-breeding species have demonstrated a noticeable correlation with the forest restoration process (de Sousa *et al.* 2014) and with the effects of urbanization (Kavazos & Wallman, 2012). In this way, it seems that these species may act as a plausible environmental indicator of the human anthropic effects.

The páramo ecosystem is under various pressures related to human activities, as described above. These threats have led decision makers to assume national policies for the conservation of páramo hydrological resources. Although the physical and geographical delimitation of the páramo area is methodologically complicated, it is necessary to implement this in law. A coherent proposal for delimitation includes the use of focal and endemic fauna, or indicator species, as biophysical criteria (Rivera-Ospina & Rodriguez, 2011). Thus, all of the bionomic traits previously mentioned, and the proposal as a potential ecological indicator, make the carrion-breeding blow flies an interesting taxon to study in the context of páramo conservancy.

This pioneering study investigates blow fly species inhabiting the Andean Páramos attempts to: a) inventorying and monitoring the assemblage of carrion-breeding blow flies in the Belmira Páramo during two years; b) to offer updated faunistic and ecological information through an annotated checklist of the blow flies inhabitant the Páramo ecosystem; c) to outline the possible effects of the human presence over the diversity of blow flies in the Páramo ecosystem. Finally a brief consideration about the origin and chorological aspects of the Calliphoridae fauna is discussed. By considering all these aspects, we provide a basic ecological and faunistical background of carrion-breeding blow flies in the Andean Páramos for further ecological studies in forensics and conservancy.

MATERIALS AND METHODS

Study site: The area is located in northwestern Colombia, in the central Andes Cordillera, ranging between the coordinates of 6°40'17.904"N-6°36'1.868"S-75°38'50.700"E, and 75° 41'52.150"W. Thirteen field expeditions took place between February 13th, 2012, and February 18th, 2014. Four sampling sites were located in the buffer zone of the páramo and the other four within the Integrated Management District (DMI) (Fig. 1), arranged in a gradient of proximity to the nearest human settlement (the town of Belmira). All of the localities are above the altitude of 2600 m and comprise regions of typical páramo mosaic landscape, from preserved to highly anthropized (including high Andean forest remnants, the typical physiognomy of the grassland páramo at the locale is above the approximate altitude of 2950 m). The vegetation coverage of each sampling location is detailed in Table 1.

Collection and identification: Van Someren-Rydon (VSR) traps were placed in eight localities within the study area. At each localition, 3 to 12 VSR traps (Table 1) were used, baited with rotten fish heads 3 days old (250 gr). The traps were emptied after 48–72 hours of operation and all of the collected flies were counted, tabulated, and identified following Whitworth (2014)(Dear, 1979) Amat *et al.* (2008), Grella *et al.* (2015), and Whitworth (2012, 2014) respectively. Male specimens by each species collected were dissected to compare their genital structures with the specialized literature. The taxonomic classification of the Toxotarsinae considered here, follows the validity of the names found in the database Systema Dipterorum (Pape & Thompson, 2013) based on the proposal of Dear (1979).

Data analysis: The diversity data gathered for the complete area and each individual locality was analyzed and compared based on expected diversity profiles and the effective numbers of species (Hill numbers) (Chao and Jost, 2015), and the species richness estimations which were based on rarefaction by interpolation or extrapolation standardized by a given number of individuals sampled (Chao *et al.* 2016). In this case, the given number was set at 967 individuals (the highest value of individuals in a single locality) to compare among the localities, and at 2000 individuals to compare among category of human influence. Three different values of the diversity according the order of coefficient q were considered (the parameter q determines the measure of sensitivity to the species' abundances), where $q = 0$ for the absolute number of species, $q = 1$ for the exponential of Shannon entropy, and $q = 2$ for the inverse of Simpson dominance or concentration. The sampling efficiency was assessed using the mean of non-parametric richness estimators, the abundance-based coverage estimator (ACE), and the Jack1 and Chao1 estimators (Chao *et al.* 2009; Colwell 2013) as a unit of expected diversity when $q = 0$. The Jaccard coefficient and complementarity index were calculated as a measure of the turnover and complementarity in species composition between localities. The synanthropic index (SI) was calculated following the Nuorteva (1963) equation; and contrasting anthropic localities classified by their proximity to the human settlement were considered as follows for calculation purposes: 3 and 5 were considered as having a low level of human influence; 2 and 4 as having an intermediate level; and 1 and 6 as having a high level (Table 1). Each species were categorized as eusynanthropic (>+20), hemisynanthropic (0-+20) or asynanthropic (<0) as explained above. The relative abundance trend during the collection period of two years was recorded and plotted in a time series graph.

All of the specimens collected in this survey were deposited in the Colección Entomológica del Tecnológico de Antioquia (CETdeA). The collected materials and those deposited and revised in the entomological museum of Pontificia Universidad Católica del Ecuador in Quito, Ecuador (QCAZ-I), the entomological collection at the Instituto de Investigación de Recursos Biológicos Alexander von Humboldt (IAvH) in Villa de Leiva, Colombia, the Museo del Instituto de Zoología Agrícola Francisco Fernández Yépez in Maracay, Venezuela (MIZA), and a review of literature served to compile the annotated checklist. In the specimens examined section, information included in brackets [] corresponds to additional or supplementary information not contained in the label. Information data of most specimens collected in this survey was omitted in the section of specimens examined, since all information is explicit along the tables 1 and 3.

RESULTS

A total of 7 660 carrion-breeding flies specimens were collected, with Calliphoridae being the most abundant (4 144–53.7%), followed by the families Sarcophagidae (1 058–13.8%), Muscidae (877–11.4%), Fanniidae (838–10.9%), Tachinidae (476–6.2%), and Anthomyiidae (297–3.8%). Six species comprised 4 114 of the carrion-breeding blow fly samples collected; two species were of Chrysomyiinae: *Compsomyiops verena* (Walker, 1849) and *Hemilucilia semidiaphana* (Rondani, 1850); two species were of Toxotarsinae: *Roraimomusca roraima* (Townsend, 1935) and *Sarconesiopsis magellanica* (Le Guillou, 1842); one species was of Calliphorinae: *Calliphora nigribasis* (Macquart, 1851); and one species was of Luciliinae: *Lucilia purpurascens* (Robineau-Desvoidy, 1830). The trends in abundance were dominated by three species. The most common species in the entire survey was *Compsomyiops verena* (3 631–88%), followed by *Calliphora nigribasis* (363–9%) and *Roraimomusca roraima* (114–3%). The other three species were with only two individuals collected for each species.

The values of the proportional species observed in all of the localities were greater than 93%, and for the complete area were 95% of the richness values ($q = 0$) expected for the estimators ACE, Jack1, and Chao1 (Table 2). This indicates that the sampling effort was sufficient and the areas assessed were well-sampled. Four localities were composed with the richest value of four species (Table 2). The values of the extrapolated richness at 967 individuals give us an estimate of five localities (2, 3, 5, 7, and 8) with the highest richness value (4 spp). Nevertheless, considering the mean of the species estimators ($q = 0$), two localities (5 and 8) show a slightly higher value estimate and a less proportional number of species observed (93%). Two localities (4 and 6) were of 3 spp. Only one locality (1) was 1 sp (Table 2). The highest value of the diversity order $q = 1$ (${}^{1}D$), was calculated for locality 5 (Alto del rio), followed by localities 7 (Montañitas) and 8 (El morro); the lowest values were for localities 4 and 1 (Quebradona and Yuyal). The same hierarchical ordination was seen for the diversity order $q = 2$ (${}^{2}D$) (Table 2). According to the diversity profile expected, we found all of the localities were highly uneven; although locality 5 (Alto del rio) is unambiguously the most diverse in the orders of $q = 1$ and 2. On the other hand, the least diverse locality in all orders of q was 4 (Quebradona) (Fig. 2), with the exception of locality 1 (Yuyal) with only one species observed (values for this locality for q = 1 and 2 were not calculated). A third set is observable, comprised of the rest of the localities in a successive pattern of similar slopes (Fig. 2), except for locality 7 which overlaps with localities 2 and 3 (Fig. 2). When the localities are considered along the anthropized gradient, all of the diversity values clearly tend to increase when moving away from the human settlement (Fig. 3).

The average number of species among the localities was 3.3 species, and the most common three species in the assemblages were: *Compsomyiops verena*, *Calliphora nigribasis*, and *Roraimomusca roraima* in 7 localities, which corresponds with the most abundant species as mentioned above. According to the average of the Jaccard index ($\tilde{x}$=0.61; +/-SD 0.23) and the Sørensen index ($\tilde{x}$=0.83) for all of the pairs of localities, a moderate degree of species turnover in composition and a substantial resemblance in relative abundance distribution among localities were evident. The most similar localities in the relative species abundance and composition were 2 and 5 (El indio and Montañitas), 3 and 4 (El morro and Malvaza), and 6 and 7 (Montañitas 2 and Quebradona). The most different localities in species composition were 1 paired with the rest of the localities except 4 and 6. These pairs also are in agreement with the highest values of the complementarity index (0.75). During all of the thirteen field expeditions, except the one in February of 2014 that took place at locality 1 (Yuyal), the pattern of the relative species abundance was identical, and the dominant species was *Compsomyiops verena*, followed by *Calliphora nigribasis* and *Roraimomusca roraima* (Fig. 4). When comparing the diversity among the localities by the category of human influence (low, intermediate, and high) based on extrapolated diversity values (${}^{0}D$; ${}^{1}D$; ${}^{2}D$) at 2000 individuals, the data were as hierarchically expected, described as follows: low (5.3; 1.7; 1.39), intermediate (4; 1.7; 1.38) and high (3; 1.46; 1.28). Additional biological data by species is provided below.

Annotated species list

Calliphorinae

Genus *Calliphora* Robineau-Desvoidy

Calliphora nigribasis (Macquart, 1851)

This is a South American endemic species of wide distribution in the highlands. It occurs from Argentina to northern Venezuela throughout the Andes Cordillera. In Peru, Baumgartner and Greenberg (1985) reported this species as a eurythermal species (as *C. peruviana*), collected from 1300 m on the eastern slope and above 2650 m on the western slope, with an unknown upper limit; a female was collected at 5008 m. In Ecuador, this species is recorded above 2600 m and surrounding the urban area of Quito, reaching localities to over 3376 m above sea level in the Antisana and southeast to the Llanganates Páramo. In Colombia, this species is reported above 2200 m in the Santander province (Wolff & Kosmann 2016), and inhabiting the urban areas and outskirts of Bogotá (Lopez-Cepeda & Fagua 2015). In Venezuela, this species also seems to be a eurythermal species, collected in the urban environments of Caracas (approx. elevation of 1000 m), to the east of the country in the Tachira province (elevation of above 2300 m), and towards an altitude of 2760 m in the El Tamá Páramo. In this study, *C. nigribasis* occurred in all of the locations except in locality 1, which was nearest the human settlement. These results corroborate the species' asynanthropic behavior, here with a more evident tendency to dwell in rural areas (SI = -36.5), than as was shown in Peru (SI = +27) (Baumgartner and Greenberg 1985). A detailed morphological re-description, taxonomy, and nomenclature history may be found in Whitworth (2012).

Specimens examined: 4 males, 14 females. **Colombia:** (1 male): 1 male, Boyacá, S[antuario de] F[auna y] F[lora] Iguaque, Paramo de Iguaque, Lagunillas, 5º41’00”N, 73º27’00”W, 3380m, 18.v.2001, P. Reina Leg. 110991. (IAvH). **Ecuador:** (2 males, 10 females): 1 male, 5 females, Napo, Papallacta, 0°22’23.24”S78°8’22.35”O, 3376m, Oct 31,2015, M. Domínguez, V[an] S[omeren] R[ydon] mod[ificada] (QCAZ-I); 4 females, 200876QCAZ, 200879QCAZ, 200880QCAZ, 200845QCAZ, Tungurahua, Páramo de Llanganates, -0.991041lat, 78.320057lon, 3342m, 25.ii.2015, S. Aguirre, Mac phail mod[ificada] (QCAZ); 1 male, Same data, except 200846QCAZ, 24.ii.2015, -0.972605lat, 78.245627lon, (QCAZ-I); 1 female, Same data, except 200878QCAZ, 22.ii.2015, (QCAZ-I). **Venezuela:** (1 male, 4 females): 1 male, 1 female, Tachira, Betania, 2325m, Aug 7-8, 1972, J.B. Tera, J. Salcedo, (MIZA); 2 females, Same data, except Tachira via páramo El Tama, 2425m, March 16-20,1983, (MIZA); 1 femal, Pico Naigata, 2765m, March 24, 1978, A. Montagne (MIZA).

Chrysomyiinae

Genus *Chrysomya* Robineau-Desvoidy

***Chrysomya albiceps* (Wiedemann, 1819)**

This is an introduced species, native to the African and Mediterranean regions and commonly found in the lowlands of the New World. This species can reach elevations up to 3320 m on the eastern slope of the Peruvian Andes, being a eurythermal species (Baumgartner and Greenberg 1985), and has become widely distributed in Central and South America since its introduction. Not found it in the Colombian and Venezuelan páramos, but its future settlement in those areas is inevitable. This is a very frequent species on all of the ridges at median elevations in Colombia (Amat 2009; Florez & Wolff 2009). Here, we report the highest altitude for this species on record, 3376 m, as well as the first recording of this species in the Antisana Páramo of Ecuador. Aspects of the biology, ecology, and bionomics of this species have been relatively well-studied due to its medical and forensic importance. For morphological details and phenotypic polymorphisms of neotropical specimens, see Grella *et al.* (2015).

Specimens examined: (1 male, 3 females) **Ecuador:** 1 male, 3 females, Napo, Páramo de Antisana, Papallacta, 0°22'23.24"S, 78°8'22.35"O, 3376m, 31.x.2015, M[ariela]. Domínguez, V[an] S[omeren] R[ydon] mod[ificada] (QCAZ-I)

Genus *Compsomyiops* Townsend

***Compsomyiops boliviana* (Mello, 1968)**

This is a common species found from the highlands to nival elevations, and distributed from Bolivia to Ecuador (Dear 1985). In Colombia, this species was reported in the Chingaza Páramo colonizing a pig carcass by Martinez *et al.* (2007). In Peru, this species was a common fly above the elevation of 3550 m and was associated with pastures (Baumgartner & Greenberg 1985). We did not find specimens that matched the characteristics of *C. boliviana* proposed by Dear (1985).

***Compsomyiops verena* (Walker, 1849)**

This is a montane species that is distributed from Costa Rica to Peru (Dear, 1985). In Peru, this is a prevailing eurythermal species that ranges in altitude from 1200 to 3000 m (Baumgartner

& Greenberg 1985). The same distributional altitude pattern is known for the Colombian Andes (Amat 2009), where this species is of forensic and medical importance, especially in urban environments (Florez & Wolff 2009; Lopez-Cepeda & Fagua, 2015; Segura *et al.* 2011). *C. verena* was the most frequent species in the Belmira Páramo, occurring in all of the sampled localities. Although the synanthropic index calculated was positive (SI = 7.4), the species seems to display hemisynanthropic behavior at this altitude. Extra sampling within the urban area is necessary to corroborate its categorization as eusynanthropic by Pinilla-Beltran *et al.* (2012). This species' taxonomic description and nomenclatural history is detailed in Dear (1985); however, despite his revision, the species belonging to this genus occurring in the northern Andes are in need of a detailed taxonomic revision, since the male genitalia are almost indistinguishable among *C. boliviana* and *C. melloi*.

Specimens examined: (9 males, 15 females). **Colombia:** (7 males) 111234IAvH, 111233IAvH, 111230IAvH, 111232IAvH, Boyacá, Villa de Leiva, Páramo de Iguaque, Cabaña, 5°40'44.12"N, 73°27'43.04"W, 2855m, 12.xii.200. P[edro] Reina Leg. Malaise Trap (IAvH). 1 male, Antioquia, Belmira, Yuyal, 06°59'91,200"N -75°6813370"W, 2612m, March 11, 2015, F. Álvarez, T[ramp04], V[an] S[omeren] R[ydon] mod[ificada], F[ish] D[ecomposition]; 1 male, Antioquia, Belmira, El morro, 06°36'45,9"N -75°39'48,2"W, 2844m, Feb 13, 2012, F. Álvarez, T[ramp03], V[an] S[omeren] R[ydon] mod[ificada], F[ish] D[ecomposition] (CETdeA). 1 male, Antioquia, Belmira, Montañitas 2, 06°62'29,3"N-74°35'06,7"W, 3095m, Oct 4, 2012, F. Álvarez, T[rampa08], V[an] S[omeren] R[ydon] mod[ificada], F[ish] D[ecomposition]. (CETdeA). **Ecuador:** (2 males, 15 females), 1 male, 6 females. Napo, Páramo de Antisana, Papallacta, 0°22'23.24"S, 78°8'22.35"O, 3376m, 13.x.2015, M[ariela]. Domínguez, V[an] S[omeren] R[ydon] mod[ificada] (QCAZ-I); 1 male 200724QCAZ, 9 females, Tungurahua, Páramo de Llanganates, -0.991041lat, 78.320057lon, 3342m, 21.ii.2015, S[aul]. Aguirre, Mac phail mod[ificada] (QCAZ-I).

Genus *Hemilucilia* Brauer

Hemilucilia semidiaphana **(Rondani, 1850)**

This is a neotropical species of wide distribution, from Mexico to Argentina (Dear 1985). It is recorded as an asynanthropic species in the Peruvian Andes and is one of the most frequent species at the altitude of 1200 m on the eastern side (Baumgartner & Greenberg 1985). In the Colombian Andes, this species occurs in all of the ranges and reaches the altitude of 2500 m (Wolff & Kosmann 2016). In Colombia, it has been reported to have forensic importance and the immature stages were described by Florez & Wolff (2009). This paper reports the highest altitudinal record for this species, above 3000 m. However, only two individuals were collected in localities 2 and 6. We consider this species to be not fully established in this ecosystem. A detailed revision on the Andean fauna belonging to this genus is needed, as sympatric species may coexist.

Specimens examined: (2 females) **Colombia**: 1 female, Antioquia, Belmira, Páramo de Belmira, El indio. 6°37'58.82"N; 75°41'22.91"W, 2700m,1-5.iii.2012, F[ederico]. Álvarez, T[ramp03], V[an] S[omeren] R[ydon] mod[ificada], F[ish] D[ecomposition] (CETdeA). 1 female; 1 female, Antioquia, Belmira, Páramo de Belmira, Montañitas. 6°37'23.11"N; 75°38'52.02"W. 3088m. 9-13.ii.2012, F[ederico]. Álvarez, T[rampa]03, V[an] S[omeren] R[ydon] mod[ificada], F[ish] D[ecomposition] (CETdeA).

Luciliinae

Genus *Lucilia* Robineau-Desvoidy

Lucilia purpurascens (Robineau-Desvoidy, 1830)

This is a neotropical species of wide montane geographical distribution, from Mexico to Argentina. In the Andean region of Peru, this species is quite common from the altitude of 1300 m to that of 1900 m on the eastern slope, and has hemisynanthropic tendencies (Baumgartner & Greenberg 1985) (as *Phaenicia purpurascens*). In Colombia, it was recorded as reaching the elevation of 2800 m (Wolff & Kosmann 2016) in a rural location near the area that was assessed in this study. Ramírez-Mora *et al.* (2012) reported this species (as *Lucilia peruviana*) as common in the Andean valley outskirts of Medellin. Only two specimens were collected in this study, in the localities 3 and 8. This is the first record of this species occurring above the altitude of 3000 m. This species seems to be a frequent element of the Andean forest remnants with different anthropic levels at this latitude. For this reason, we considered it to be an asynanthropic species (SI = -25) that is not fully established in the páramo ecosystem. It is possible their occurrence may be accidental due to their foraging habits and dispersal capacity.

This species is one of the most distinctive species of the genus, and the morphology, details of genital structures, and diagnostic characteristics may be consulted in Whitworth (2014). The historical nomenclature and the designation of the Costa Rican neotype is explained in detail by Whitworth & Rognes (2014).

Specimens examined: (2 females), **Colombia:** 1 female, Antioquia, Belmira, Paramo de Belmira, El morro, 06°36'45,9"N -75°39'48,2"W, 2844m, 5-9.i.2013, F[ederico]. Álvarez, T[rampa] 13, V[an] S[omeren] R[ydon] mod[ificada], F[ish] D[ecomposition] (CETdeA). 1 female, Antioquia, Belmira, Paramo de Belmira, Malvazá, 6°38'28.34"N, 75°41'55.15"W, 2757m, 11.ii.2013, F[ederico]. Álvarez, T[rampa]9, V[an] S[omeren] R[ydon] mod[ificada], F[ish] D[ecomposition] (CETdeA).

Toxotarsinae

Genus *Sarconesia* Bigot

Sarconesia magellanica (Le Guillou, 1842)

This high-altitude Andean and eastern South American species is widely distributed from Chile to Colombia up to an elevation of 3250 m (Dear 1979). In Peru, it was recorded as ranging from 1800 to 4000 m on both Andean slopes, and was reported as a eusynanthropic and endophilic fly (Baumgartner & Greenberg 1985). In Colombia, this species seems to be common on every ridges (oriental, central, and occidental) from above 1800 m to 3100 m (Amat 2009), and hemisynanthropic in the outskirts of Bogotá (Pinilla-Beltran *et al.* 2012). This species is reported as having forensic importance for being an active carcass colonizer in high elevations (Florez & Wolff 2009; Segura *et al.* 2011). The biology of this species, including its lifecycle and populational parameters in the laboratory, were studied by Pinilla *et al.* (2013), and recently this species has been studied as a promissory species in larval therapy, especially for the effects of treating chronic wounds in animals with hemolymph (Góngora *et al.* 2015). *S. magellanica* was a rare species in this survey, with only one specimen collected in locality 5 (Alto del rio). The species appeared to avoid human settlements and is not fully established in the disturbed páramo localities.

Specimens examined (4 females). **Colombia:** 2 females, Antioquia, Belmira, Páramo de Belmira, Alto del rio. 6°40'9.42"N; 75°42'3.54"W, 2921m, 22.x.2013, F[ederico]. Álvarez, T[rampa 04], V[an] S[omeren] R[ydon] mod[ificada], F[ish] D[ecomposition] (CETdeA). **Ecuador:** 2 females, Antioquia, Páramo: Napo, Páramo de Antisana, Papallacta,, 0°22’23.24”S78°8’22.35”O, 3376m, Oct 31,2015, M. Domínguez, V[an] S[omeren] R[ydon] mod[ificada] (QCAZ-I);

Sarconesia roraima **(Townsend, 1935)**

This species is a high altitude Andean endemic species that is distributed from Bolivia to Venezuela. Little is known about its biology as it was not recorded in the classic study of Peruvian fauna by Baumgartner & Greenberg (1985). Pinilla-Beltran *et al.* (2012) and Lopez-Cepeda & Fagua (2015) report this species as an asynanthropic fly that is highly abundant in the forest and rural areas during the rainy season in the surrounding montane areas of Bogotá, Colombia. This is a very distinctive species, easy to recognize by their yellow hairy eyes, which are not a common characteristic in blow flies. The morphology and genital diagnostic characteristics of the species may be consulted in Dear (1979), Amat (2009), and Amat *et al.* (2008). In this survey, *R. roraima* was a common asynanthropic species (SI = -31) with tendencies to appear in rural places. The first author of this paper noticed a particularly vigorous and erratic courtship behavior in this species that involved some males trying to mate with other species during the daytime in a well-preserved Andes mountain forest in Napo, Ecuador. Even though Mount Roraima in the Guyana Shield is not comprised of páramos, we report some additional high-altitude records from this locality in the eastern and others in central Venezuela. **Specimens examined** (3 males, 3 females) **Venezuela:** 1 female, Bolivar, Cerro Roraima, Gran Sabana, 2700m. 12-21.i.1991. Exp[edición] Terramar, A. Chacón (MIZA); 1 female, Bolivar, Roraima, 2810m, 30.viii.1987, CEUM Facultad Agronomia U.C.V. Maracay (MIZA).; 1 female, M[uni]cipio Vargas, D.F. Jenjibrillar, 2300m, Geremba, 3.ix.1994, Luis A Campos (MIZA); 3 males, D[epartamen]to Federal, Est[ación] Exp[erimental] Bajo Seco, Virologia-El Junquito, 1900m, 17.iv.1976, C.J. Rosales col[ectó] (MIZA).

Sarconesia splendida **(Townsend, 1918)**

This is a typical high-altitude Andean species that is distributed from Bolivia to Ecuador (Dear, 1979). The northernmost record was documented in the Sumapaz Páramo of Colombia at an elevation of 3560 m (Amat, 2009). In central Peru, this species is found from above 3250 m to the nival level. It is a hemisynanthropic fly with evident carrion- and dung-feeding habits (Baumgartner & Greenberg, 1985). No specimens were collected in this survey at this latitude, and none have been recorded in the central or western mountain ridges of Colombia. The morphology and genital diagnostic characteristics of this species may be consulted in Dear (1979), Amat (2009), and Amat *et al.* (2008).

Specimens examined (18 females) **Ecuador**:, Napo, Páramo de Antisana, S0°27'34.3 W78°09'7", 4047m, 2016.vii.08, E[milia]. Moreno Leg. Pitfall 222012QCAZ to 222029QCAZ (QCAZ-I).

DISCUSSION

Diversity: Although the carrion-breeding blow flies of the family Calliphoridae were the most abundant in this study, which corroborates their dominance in the tropical Andean carrion fly assemblages (Amat *et al.* 2013), the overall richness of the Calliphoridae family was remarkably low when compared with other Calyptratae carrion fly families (e.g., Sarcophagidae, Muscidae, and Fanniidae) and also in contrast with the blow fly fauna of other biogeographical regions. The páramo ecosystem was not the exception for this tendency. The richness and the abundance distributions found during this study are similar to those calculated for high latitudes of Holarctic environments. These assemblages usually fit the "geometric series" model of biological communities that is described as poor in species richness with a high dominance of few species (Kuusela & Hasnki 1982). This ecological condition may be the result of two possible causes: a moderated speed of habitat colonization, and a slow rate of the páramo species developing their own realized niches; both of these can occur in recently structured and consolidated ecosystems, such as the tropical high montane ecosystems. More specifically, the time taken to develop the current páramo environments, within the last 3–5 MYA after the Andes uplift, still may not be enough time for carrion-breeding blow flies to fill the ecological niches in the inhospitable climatic conditions of this ecosystem. Based on the low richness values of Calliphoridae in neotropical environments, the richness observed in the material revised from the entomological collections, the richness values obtained during this study, and the time elapsed since the last species was described at high Andean elevations (*Compsomyiops boliviana* in 1968), we foresee a low probability of a new Calliphoridae species appearing at these elevations.

Anthropic effects: If the diversity data of all of the orders are compared by localities, it is clear that the locality that is less perturbed, Alto del rio (locality 5), which is located farthest from the human settlement, followed by El morro (locality 8) within the conservational area delimited for the Belmira Páramo have the highest diversity values. This same tendency was evidenced in the anthropized gradient of localities (Fig. 3). We may anticipate that the effect on the páramo due to urbanization and human activities strongly alters land surfaces, habitat structure, and ecological function well beyond the boundaries of the urban area (Grimm *et al.* 2015). These changes may affect the availability of resources (food, shelter, microhabitats, and number and types of exposed carcasses) and ecological relationships (predators' densities and biomass consumption, among others) for carrion flies. This often promotes the persistence of exotic species (Kavazos & Wallman 2012); however, such a situation has not yet been observed in the páramo assesed, where one species is clearly dominant (*C. verena*). Additional biological, ecological, and bionomic data of the dominant species is needed to explain its dominance in the Belmira Páramo.

Decreased values in diversity (q = 0) along the gradient toward the human settlement was in particular due to the disappearance of *S. magellanica*; which was only observed in the locality 5. This is unusual, since this species used to be common and hemisynanthropic in the Colombian western ridge (Pinilla-Beltran *et al.* 2012). Also, *L. purpurascens* was only observed only in localities 3 and 8 (both distant from the human settlement). The values when the order of diversity was q = 1 also tended to decrease, which reflects the variation at different rates of the relative species abundance for two species: being more sensitive for *Calliphora nigribasis* (occurring only at locality 7), followed by *Compsomyiops verena*, the latter of which had fewer specimens but still occurred in all of the localities surveyed. The diversity order q = 2 also tended to decrease; this is due the remarkable dominance of *C. verena* in the localities nearest to the human settlement (1, 6, and 7). The same pattern was seen when the localities, classified in groups from low to high human influence (used to calculate the synanthropic index), were analyzed based on the diversity values (^0D; ^1D; ^2D). The effect of human activities, including the urbanization process, on the Belmira Páramo had evident significance in the assemblage's composition of carrion-breeding blow flies. It appears that the proximity condition, when approaching the human settlement, induces a reduction of diversity in all orders of magnitude, and the presence or absence of a specific sets of taxa or even species may serve to infer indirectly a degree of habitat perturbation by anthropic origins as a possible ecological indicator.

Faunal composition and seasonality: The current páramo blow fly fauna seem to have three evident biogeographical taxa components. The first comprises a neotropical montane endemic taxon, encompassing species of the *Calliphora* and *Compsomyiops* genera (not closely related) which are apparently well-established in these elevation ranges. This group also includes the species of the *Lucilia* and *Hemilucilia* genera, which have clear tendencies toward median altitudes and rarely colonize at the páramo's elevation. The second component is a temperate taxa of high montane distribution in the central and northern Andes. This group seems to be phylogenetically closely related (all are genera of the Toxotarsinae) and probably shared a common ancestor with circum-antarctic or amphinotic distribution (Australia and South America). This geographical distribution has been widely documented in flora and fauna, and these taxa extend their ranges northward along the Andean montane chain and can reach high elevations as they approach the equator (some as far as Colombia and rarely to Venezuela). This is a very well-known distribution pattern in Diptera (Amorim 2009). The last component comprises the exotic element: *Chrysomya albiceps*, which has become widely distributed in South America since its introduction in the seventies. This species is abundant from median to high elevations and is a strong flier species, probably with enhanced dispersal due to its hitchhiking and synanthropic habits (Baumgartner & Greenberg 1984). Thus, the establishment of this species in northern anthropic páramo areas (Colombia and Venezuela) is expected as mentioned above. A brief approach of possible origins for these taxa according their synanthropic tendencies is given in Table 4. Seasonality and remarkable changes in species abundance were not noticed during the two years of this study. It is probable that the permanent climatic conditions (low monthly temperature, solar radiation, and humidity variation, among others) of the páramo have had effects on the life history of the blow flies, and therefore on their bionomical traits.

In order to set the páramo conservational policies, based on a faunistic surrogate group; the carrion-breeding blow flies may serve as a target taxon of study, due to their low number of species, ease of collection, stable taxonomy in the region, and high sensitivity to anthropic and possibly global warming effects. We highly recommend phylogenetic (molecular and morphological) studies at a species-level focused on páramo Dipterans. Consequently, the biogeographical patterns of higher Diptera in the Andean region may be better hypothesize. In addition, the dynamics of carrion colonization and some others ecological interactions (e.g. competition, predation, parasitism, among others) associated to the ephemeral resources in this ecosystem should be studied. The synanthropic tendencies and geographical distribution by species encountered was discussed in the annotated list above.

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RESUMEN

Se estudia y monitorea la diversidad de moscas carroñeras (Diptera: Calliphoridae) del Páramo de Belmira (norte de la región andina colombiana). Se presenta una lista anotada de las especies de Calliphoridae presentes en los Paramos Andinos. Se evidencia una progresiva reducción en los valores de los tres órdenes de diversidad evaluados ($^{0,1,2}D$) a medida que se aproxima al asentamiento humano. No se evidenció estacionalidad marcada en la abundancia específica a lo largo de los dos años de estudio y finalmente se ofrece una breve discusión sobre la composición faunística de moscas carroñeras en este ecosistema y su plausible uso en la indicación de procesos antropogénicos. Pretendemos proveer información básica de las moscas carroñeras para futuros estudios ecológicos, conservacionistas y forenses en el páramo Andino.
Palabras clave: Andes, *Chrysomya*. Entomología forense, diversidad verdadera, antropización

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TABLE 1

The geographical and ecological information for the collection sites

N° Site	Locality name	Coordinates	Vegetation coverage	Altitude (m.a.s.l)	Distance to nearest human settlement (km)	Category of Human influence
1	Yuyal	6°36'3.67"N; 75°40'53.11"W	Pasture	2649	1.6	High
2	El indio	6°37'58.82"N; 75°41'22.91"W	Shrubs and forest remnants	2700	3.7	Intermediate
3	Malvazá	6°38'2;8.34"N, 75°41'55.15"W	Pasture, shrubs and forest remnants	2757	5.1	Low
4	Quebradona	6°38'9.93"N; 75°39'48.58"W	Grassland, shrubs and forest remnants	2900	3.4	Intermediate
5	Alto del rio	6°40'9.42"N; 75°42'3.54"W	Grassland, shrubs and forest remnants	2921	7.8	Low
6	Montañitas 2	6°36'49.55"N; 75°39'20.65"W	Grassland, shrubs and forest remnants	2956	1.4	High
7	Montañitas	6°37'23.11"N; 75°38'52.02"W	Grassland, shrubs	3088	2.7	-
8	El morro	6°38'27.43"N; 75°40'19.84"W	Grassland, shrubs and forest remnants	3127	3.9	-

m.a.s.l. = meters above sea level; km = kilometers.

TABLE 2

The species data diversity for each site

N° Site	Site name	Nt	Ni	Rs	$R_{s=967}$	ACE	Jack1	Chao	$\tilde{x}$	%	Obs.		Exp.	
											^1D	^2D	^1D	^2D
1	Yuyal	4	504	1	-	-	-	-	-	-	-	-	-	-
2	El indio	10	967	4	4	4	4.8	4	4.2	95.2	1.56	1.28	1.57	1.28
3	Malvazá	12	786	4	4	4	4.8	4	4.2	95.2	1.57	1.30	1.58	1.31
4	Quebradona	3	414	3	3	3	3	3	3	100	1.12	1.01	1.12	1.04
5	Alto del rio	12	385	4	4	4	4.9	4	4.3	93	1.98	1.55	1.98	1.56
6	Montañitas 2	3	68	3	3	3	3	3	3	100	1.60	1.31	1.63	1.31
7	Montañitas	5	398	4	4	4	4.8	4	4.2	95.2	1.71	1.42	1.74	1.43
8	El morro	12	592	4	4	4	4.9	4	4.3	93	1.67	1.36	1.69	1.36
All	All region	61	4114	6	4.6	6	6.9	6	6.3	95.2	1.54	1.27	1.54	1.27

Nt = number of VSR traps. Ni = number of individuals. Rs = number of species observed. Rs = 967 Number of rarified species by extrapolation at 967 individuals. Species estimators of $q = 0$. ACE = Abundance-based coverage estimator. Jack1 = first order jackknife and Chao estimator. $\tilde{x}$ = average mean of the estimators. The percentage indicates the average proportion of the number of species expected. ^1D diversity values refer to $q = 1$; ^2D diversity values refer to $q = 2$.

TABLE 3

The checklist of carrion-breeding blow flies of the Andean páramos

Subfamily	**Species**	**Locality (in this survey)**	**(S.I)**	**Páramo**	**References**
Calliphorinae	*Calliphora nigribasis* Macquart, 1851	2,3,4,5,6,7,8	-36.5	Ant, Ca; Chi; Chz, Bel, Gua, Igu, Llan, Tam	Martinez *et al.* 2007, Whitworth 2012,
Chrysomyiinae	*Chrysomya albiceps* (Wiedemann, 1819)	-	-	Gua	This study
	Compsomyiops boliviana (Mello 1968)	-	-	Chz	Martinez *et al.* 2007
	Compsomyiops verena (Walker, 1849)	all	7.4	Chz, Bel, Igu, Pap, Llan	Martinez *et al.* 2007, Amat, 2009
	Hemilucilia semidiaphana (Rondani,1850)	2,7	-	Bel	This study
Luciilinae	*Lucilia purpurascens* (Robineau-Desvoidy, 1830)	3,8	-25	Bel	This study
Toxotarsinae	*Sarconesia magellanica* (Le Guillou, 1842)	5	-	Bel, Chiz, Gua, Igu	Martínez *et al.* 2007
	Sarconesia roraima Townsend, 1935	2,3,4,5,6,7,8	-31	Bel	This study
	Sarconesia splendida Townsend, 1918	-	-	Ant, Bel, Chz, Sum	Dear 1979; Amat 2009

Abbreviations for the name of the Páramo in Ecuador: Ant: Antisana; Caj: Cajas; Chi: Chiles; Gua: Guamaní; Pap: Papallacta; Llan: Llanganates. In Colombia; Chz: Chingaza; Bel: Belmira; Igu:Iguaque; Sum: Sumapaz. In Venezuela Tam: El Tamá. S.I: Synanthropic Index; (for the names of localities sampled see table 1).

TABLE 4

The synanthropic tendencies and biogeographical components of the carrion-breeding blow fly taxa (Calliphoridae) in the Andean páramos

Synanthropy	**Biogeographical region**		
	Tropical Andean	**Temperate**	**Introduced**
Asynanthropic	*Hemilucilia* spp.	*S. roraima*	-
Hemisynanthropic	*Calliphora* spp. *Lucilia* spp.	*S. splendida*	*C. albiceps*
Eusynanthropic	*Compsomyiops* spp.	*S. magellanica*	-

FIGURES LEGENDS

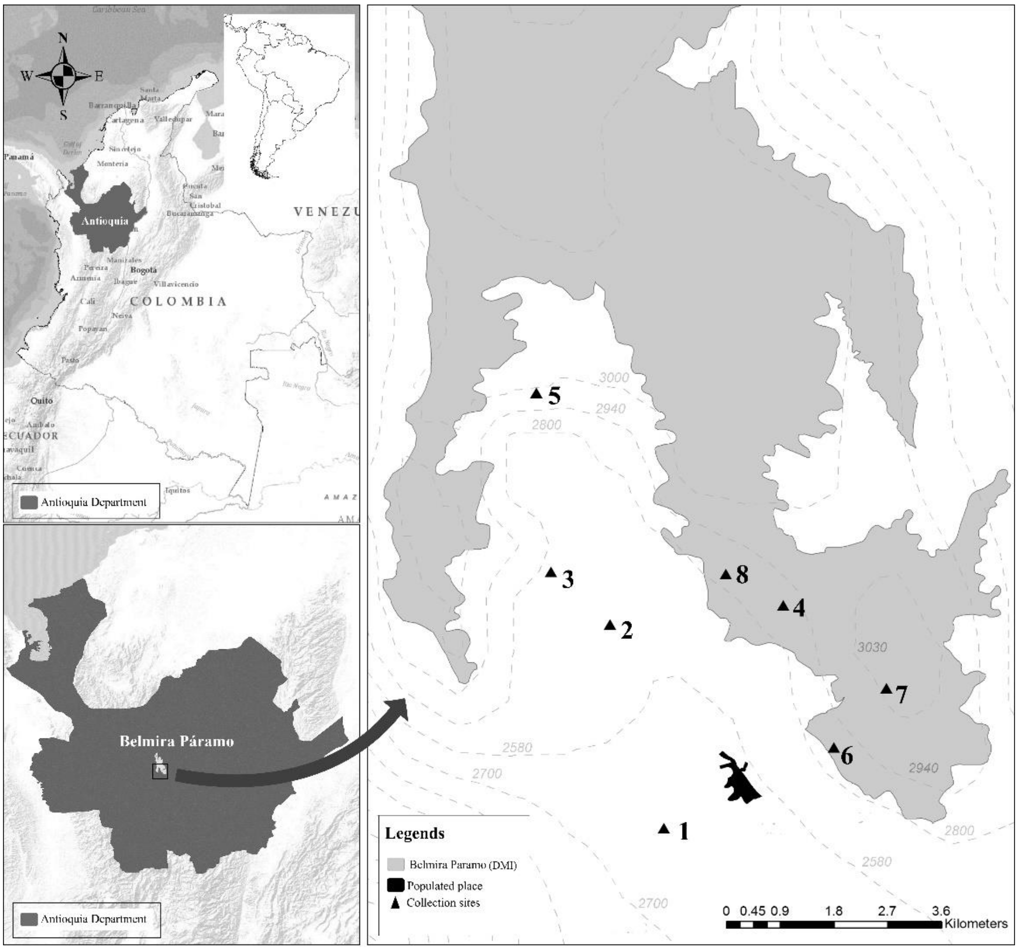

Figure 1. The geographical location of the collection sites in the Belmira Páramo, Antioquia Department of Colombia. 1: Yuyal, 2: El indio, 3: Malvaza, 4: Quebradona, 5: Alto del rio, 6: Montañitas 2, 7: Montañitas, and 8: El morro. DMI: Integrated Management District.

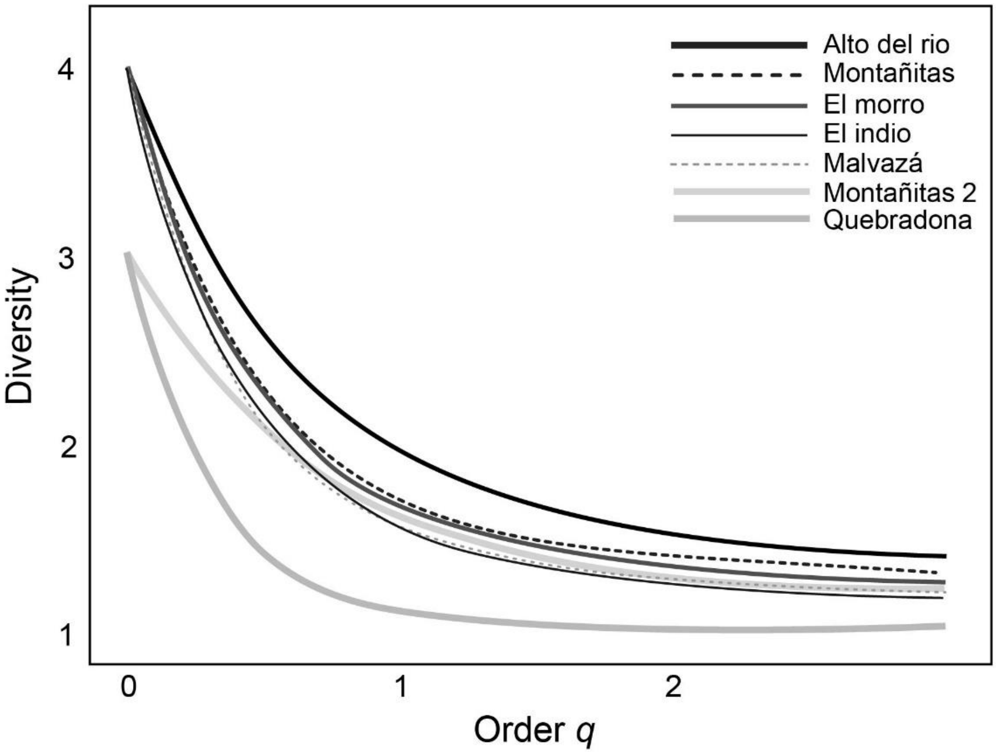

Figure 2. The diversity profile expected for q = 0, 1 and 2 of the carrion-breeding blowfly species for each assessed locality in the Belmira Páramo.

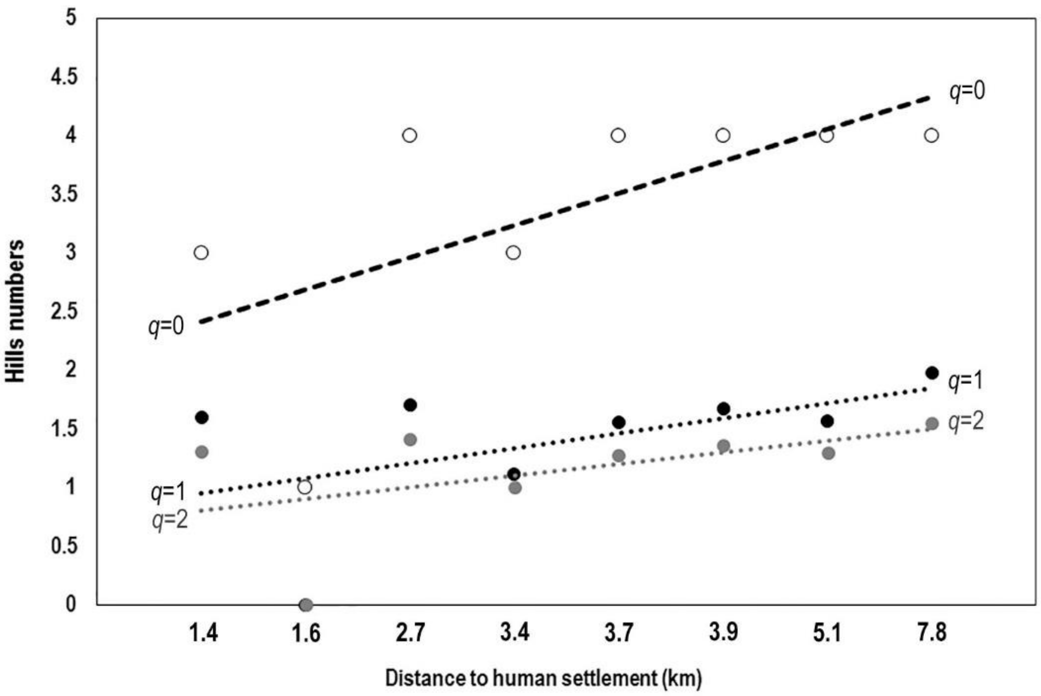

Figure 3. A linear function of the species diversity based on the Hill numbers (*q* = 0, 1 and 2) of the carrion-feeding blow fly species in relation to the distance to the human settlement.

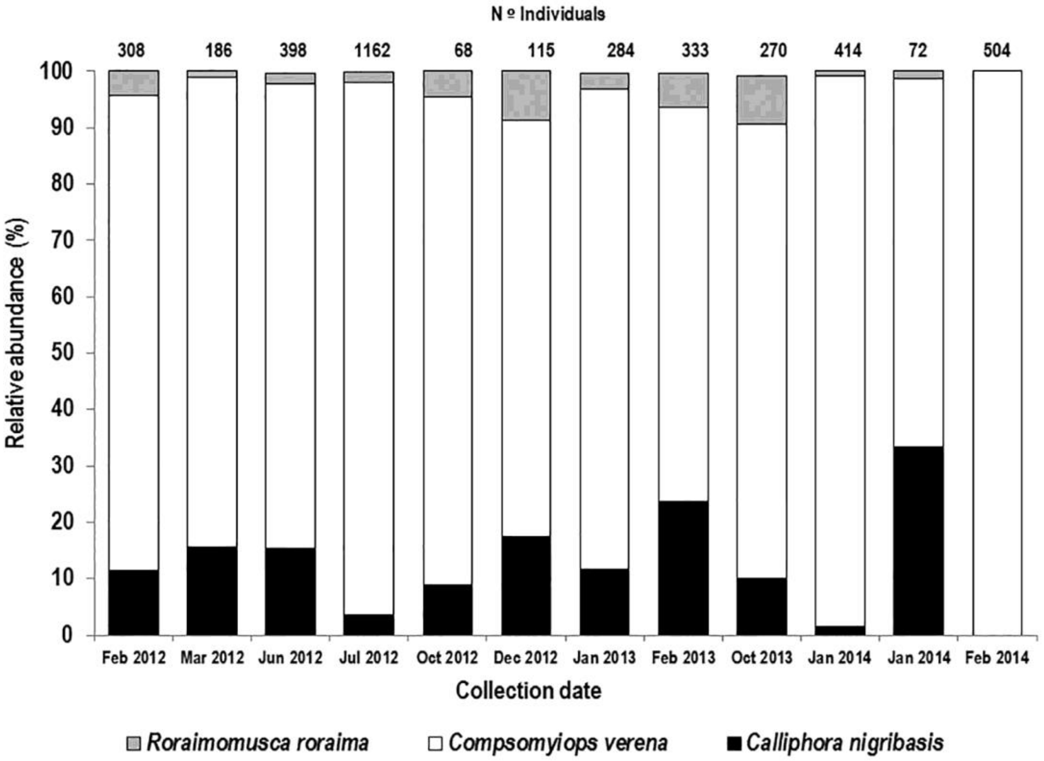

Figure 4. A time series of the relative abundance by field trip for the most frequent carrion-breeding blow flies in the Belmira Páramo.

Capítulo 4

Amat, E. Perez-Hoyos, A. Altamiranda-Saavedra, M & Rafael, J. A. to submit. The Blow fly (Diptera: Calliphoridae) fauna of Northwest South America: A preliminary geographical distribution and an annotated checklist: *Zootaxa*.

The Blow fly (Diptera: Calliphoridae) fauna of Northwest South America:

A preliminary geographical distribution and an annotated checklist

Eduardo Amat[1,2] Adriana Perez-Hoyos[2] Mariano Altamiranda-Saavedra[2] and Jose Albertino Rafael[1]

[1]Programa de Pós-Graduacão em Entomologia, Coordenacão de Entomologia, Instituto Nacional de Pesquisas da Amazônia-INPA, Manaus, AM, Brazil

[2]Grupo de Investigación Ciencias Forenses y Salud (GICFS), Tecnológico de Antioquia-Institución Universitaria, Medellín, Colombia
Corresponding author, e-mail: ecamat@gmail.com

INTRODUCTION

Flies of the family Calliphoridae (Diptera: Oestroidea) are commonly known as blow flies, bluebottles, greenbottles, cluster flies, calliphorids or screwworms. Their current classification and phylogeny are controversial and the relationship among taxa within the family is still unsolved. Calliphoridae *sensu lato* historically has been considered as a non-monophyletic clade based on the morphology (Rognes 1997), and lately corroborated by molecular data (Kutty *et al* 2010; Marinho *et al* 2012; Singh & Wells 2013). Despite the paraphyletic or polyphyletic condition, the neotropical fauna appear to be monophyletic when excluding Mesembrinellidae, taxon recently reestablished to family rank (Marinho *et al* 2016). Thus, five subfamilies occurs in the continental area: Calliphorinae, Chrysomyinae, Luciliinae, Toxotarsinae and Melanomyinae, the latter present only in Central America (Kosmann *et al* 2013; Knut Rognes 1997; Whitworth 2012).

The taxonomy of the neotropical fauna have been subject of many authors, specially of European and north American earlier dipterists whom described most of the current species. From the twenties the neotropical Calliphoridae as a whole was treated by Shannon (1926), Hall (1948), James (1970), Mariluis and Peris (1984) and Peris and González-Mora (2005). And recently the Central American genera were treated in the Manual of Central American Diptera by Vargas & Wood (2010), and the West Indies fauna was studied by Whitworth (2010). *Calliphora* was studied by Mello (1962, 1974) and Whitworth (2012). Chrysomyini was reviewed by Dear (1985), *Paralucilia*, *Hemilucilia* and *Compsomyiops* studied by Peris and Mariluis (1989), Mariluis *et al.* (1994a), Mello (1996), and González-Mora *et al.* (1998) respectively. *Lucilia* (= *Phaenicia*) was studied by Mello (1961), Mariluis *et al.* (1994b) and recently reviewed by Whitworth (2014), *Blepharicnema* by Mariluis (1979) and finally Toxotarsinae were study by Mello (1978), Lopes and Albuquerque (1982) and reviewed by Dear (1979). Taxonomic keys for morphologic identification by country were published in Argentina by Mariluis (1981a), for Brazil by Mello (2003) and Kosmann *et al.* (2013), for Colombia by Amat *et al.* (2008) and Amat (2009), and Perú by Dale (1987). In addition to all this bulk of taxonomic literature, during the last two decades important faunistics and ecological studies have contribute to the knowledge of the blow fly fauna. For the northwest South America it is worth mentioning some studies per area; in Peruvian Andes (Baumgartner & Greenberg, 1985), in Colombian Andes (Amat & Wolff 2007; Amat *et al.* in press.; Montoya-G *et al.* 2009) and in northwest Brazilian and Colombian Amazon (Amat *et al.*, 2016; Esposito *et al.*, 2010; Paraluppi, 1996; Paraluppi & Castellón, 1993; Alexandre Ururahy-Rodrigues *et al.*, 2013). Furthermore, check lists, catalogues and synopsis have been also published; the south America fauna was listed by Kosmann *et al* (2013); for country level in Colombia by (Amat 2009; Pape *et al* 2004; Ramírez-Mora *et al* 2012; Salazar-Ortega *et al* 2012; Wolff & Kosmann 2016), in Venezuela (Cova 1964; Velásquez *et al* 2017) and for the Brazilian Amazon province (Amat *et al* 2016).

In northern South America it is important to mention the contribution of several studies under the framework of forensic entomology to the bionomic aspects and biology of a considerable number of blow fly species in the region. These studies were focuses in successional patterns on pig carcass, species lifecycles and checklists; many were compiled and may be consulted in Amat & Gomez-Piñerez (2012); Mavárez-Cardozo *et al.* (2005); Salazar & Donoso (2015) and Ururahy-Rodrigues *et al.* (2013a). The immatures stages have been little studied; we highlight the larvae description of several Peruvian species by Greenberg & Szyska (1984) and Colombians by Florez & Wolff (2009), however the larval morphology of several neotropical species still remain unknown. Despite all literature available, the blow fly fauna of the South America has not been studied in a comprehensive biogeographical sense, few studies regarding biogeographical distribution or spatial patterns along altitudinal or synanthropic gradients are published.

With approximately 1500 species worldwide and 120 occurring in the Neotropical region, Calliphoridae are of great importance due to the degree of association with humans (Marshall, 2012). Most species are of medical, veterinary or sanitary importance; blow flies are strongly attracted to excrement, secretions and decaying material, thus constantly alternate between feces and human comestibles, being an efficient mechanical vectors of pathogens (Greenberg, 1971). Others species can cause myiasis (infestation of alive tissue with fly larvae) in animals and in man (Norris, 1965). In the framework of decomposition ecology, they are the most conspicuous and active macro organisms in the process of carcass reduction (Anderson & Cervanka, 2002). Furthermore, they are the most common insects used in forensic entomology; since their colonization habits may serve as a biological clock measuring the *Post mortem interval* –PMI- in criminal cases (Amendt *et al.*, 2004; Greenberg & Kunich, 2002). On the other hand, some species were used by ancient cultures for therapeutic treatment of chronic wounds, technique nowadays known as larval therapy, biotherapy or biosurgery (Sherman, 2003). Have also proven to be beneficial in agriculture, as they are efficient pollinators of fruit trees, blow flies driven a positive impact in the quality and quantity of fruits (Saeed *et al.*, 2016).

Blow flies have different tolerances to the habitat conditions, being affected by the degree of human impact on the natural environment (anthropization process), the level of preferences is commonly known entomological studies as “synanthropy” (Gregor & Povolný, 1958); thus, synanthropic, hemysinanthropic, and asynanthropic are ecological categories for classifying flies according to their degree of attraction or repulsion for human settlements (Greenberg, 1971). Moreover, in a conservational context, some studies on carrion blow flies assemblages have demonstrated a noticeable correlation with forest restoration process (de Sousa *et al.*, 2014). Lately, ubiquitous blow flies are being used as an efficient indirect method of monitoring the diversity of mammals in tropical forest, based on a mini-target mtDNA remainders allocated in the blow fly gut (Lee *et al.*, 2015).

This original study considering the geographical distribution pattern of blow flies based in natural regions attempts: a) to compile the species composition of the blow fly fauna inhabiting the northwest South America based in specimen deposited in local entomological collections and selected literature. b) to offer maps of species localities records considering six regions; Amazonian, Andean, Orinoquia, Pacific, and Tepuyan. c) to outline the preliminary patterns of the species distribution along natural regions and the altitudinal gradients. d) to gather updated taxonomical and faunistical data. Therefore, this study intend be the baseline for future biogeographical studies on blow flies of the region;, assiting the use of geographical and faunistical information in the medical, forensics and conservationist fieldwork, and encouraging further chorological studies of neotropical calyptratae flies.

MATERIAL AND METHODS

Study area

The study area is located in the Northwest extreme of South America, between the latitudes 12°N and 5°S and longitudes 59° and 80° west (Figure 1), covering an approximately estimated area of 241.663 km^2 (Table 1). It comprises the administrative boundaries of five countries: Colombia, Ecuador, Venezuela, northern Peru, and northwest Brazil (Table 1). In the biogeographical wide sense, it is possible to identify six natural regions. In order to make easy the understanding of the blow flies spatial distribution, we propose a preliminary biogeographical regionalization described below.

Regionalization

The area was divided into six regions based in a combination of criteria from Rivas-Martinez *et al.* (2011) and Morrone (2014) and are equivalent to their provinces units (Figure 1); this includes two elevated regions and four lowland regions. Demarcation of the montane areas follows an altitude criterion based on 300-400 m altitude contour line pursuing the foothills in central Colombia, Ecuador, northern Brazil and southern Venezuela respectively. The delimitation of the Pacific area correspond to a fusion of Chocó-Darien province and Western Ecuador Province sensu Morrone (2014), covering and area of 11.331 km^2 (Table 1). Although the Sierra Nevada de Santa Marta and the Serrania del Perijá systems are independents from the Andes belt, we decide to include them, since they share the same blow fly fauna (Amat, Perez-Hoyos, & Rafael, in press); consequently forming a disjoint region. Thus, the Andean region here propose are equivalent to the Colombian Andean province sensu Rivas-Martinez *et al.* (2011) fused with the Cauca province of Morrone (2014), covering 39.277 km^2 (Table 1). Caribbean area correspond to a fusion of Venezuelan province, Guajira province and the northern portion of the Magdalena province *sensu* Morrone (2014); and a merging of Guajiran-Caribbean province and Cordobesa lower Magdalena Province *sensu* Rivas-Martinez *et al.* (2011) extending for 25.772km^2 (Table 1). The Orinoquia area is equal to the Sabana province sensu Morrone (2014) an it extends for 37.101 km2; the Amazonian area is equivalent to a merging of Napo province and Imerí provinces *sensu* Morrone (2014) and to the west Amazonian province according Rivas-

Martinez *et al.* (2011) covering 103.103 km^2 (Table 1). Finally, Tepuyan area correspond to a modification of Pantepui province *sensu* Morrone (2014) and Tepuyan province of Rivas-Martinez *et al.* (2011) with a resultant area of 25.079 km^2.

Identification of taxa

In this paper we use the common name blow fly for the Calliphoridae *sensu stricto* (Calliphoridae s.s) to designate the Calliphoridae excluding Rhiniidae and Mesembrinellidae, lately recognized as different families (Marinho *et al* 2016; Marshall, 2012). We followed the subfamilies classification adopted by Rognes (1997). *Calliphora* species were identified by using the keys of Whitworth (2012). Chrysomyiinae classification and the species identification followed Dear (1985), except for *Chrysomya* whose species were identified according to Grella *et al.* (2015). Species of *Paralucilia* were identified according to Dear (1985) and Mello (1996a) and species of *Hemilucilia* were identified according to Dear (1985) and Peris & Mariluis (1989). Luciliinae genera were classified and identified according to Amat *et al.* (2008) and Pape *et al.* (2004), and *Lucilia* species by using the key of Whitworth (2014). *Blepharicnema* according to Mariluis (1979) and Toxotarsinae following the classification and the species identification key provided by Dear (1979). Specimens with doubtful identification or uncertain origin were not considered.

Geographical information

A distributional map for each species was generated based on the geographical information data consigned in the collection label of all specimens reviewed. Records without geographical coordinates were georeferenced using the online gazetteer of the NGA (National Geospatial-Intelligence Agency, 2011) or deducted and corroborated in Google Earth (Google Inc., 2015). We included 84 selected records based in the literature to complement the spatial distribution lacking in the museum records, wich are marked in the maps and consigned in the Table 2. All geographical records for each species in the Keyhole Markup language Zipped format (.kml) and the regionalization in shapefile format (.shp) proposed were mapped and generated using ArcGIS 10 software (ESRI, 2011), these files are available to download as supplementary information. We considered to include some additional records located close of the study area from the Amazonian region of Brazil, since the blow flies assemblages in the interfluvial region does not change in composition (Amat *et al* 2016) and complement the distributional data of Amazonian species. Altitudinal zonation graphic was generated according the range of the altitude values, including the outliers. All the information label of each specimen were included in the specimens examined section. Information included in brackets [] corresponds to additional information not contained in the original label. The remarks foreach species comments the current information of their geographical distribution, furthermore the bionomical aspects and synanthropy of the species, usually calculated as the synanthropic index (S.I). The S.I values ranges from -100 (avoidance for human settlements) to +100 (Affinity for human settlements). Finally, basic information for taxonomical description, morphological identification of adults and immatures are informed.

Abbreviations

Acronyms of collections and depositaries are cited here are as follows:

CETdeA Colección entomológica del Tecnológico de Antioquia, Tecnológico de Antioquia, Institución Universitaria, Medellín, Colombia (Luz Miryam Gomez Piñerez)

IAVH-E Colección entomológica- Instituto de Investigaciones Biológicas Alexander von Humboldt, Villa de Leyva, Boyacá, Colombia (Claudia Medina and Miguel Torres)

ICN-MHN Instituto de Ciencias Naturales – Museo de Historia Natural, Facultad de Ciencias, Universidad Nacional de Colombia. Bogotá, Colombia (German Amat)

INPA Coleção de Invertebrados, Instituto Nacional de Pesquisas da Amazônia, Manaus, Brasil (Marcio Luis Oliveira and Thiago Mahlmann)

MECN Museo Ecuatoriano de Ciencias Naturales. Quito, Ecuador (Santiago Villamarin-Cortez)

MEFLG Museo Entomológico “Francisco Luis Gallego” Universidad Nacional de Colombia. Sede Medellín, Medellín, Colombia (Jhon Alveiro Quiroz)

MIZA Museo del Instituto de Zoología Agrícola, Francisco Fernandez Yepes. Universidad Central de Venezuela, Maracay, Venezuela (Jose Clavijo, Nereida Delgado and Quintín Arias)

QCAZ-I Museo de Zoología-Sección Invertebrados, Facultad de Ciencias Exactas y Naturales, Pontificia Universidad Católica del Ecuador, Quito, Ecuador (Alvaro Barragan and Emilia Moreno)

UNAB Museo Entomológico, Facultad de Agronomía, Universidad Nacional de Colombia, Sede Bogotá, Colombia (Francisco Serna and Erika Valentina Vergara)

USNM National Museum of Natural History (Formerly United States National Museum), Smithsonian Institution, Washington, District of Columbia, USA. (Torsten Dikow and Eliana Buenaventura)

UPTC Museo "Luis Gonzalo Andrade". Universidad Pedagógica y Tecnológica de Colombia, Tunja, Boyacá, Colombia (Fredy Molano)

RESULTS

A total number of 13.474 specimens deposited in eleven entomological collections were examined and they were arranged into 10 genera and 28 species (Table 2). Two species belonging to Calliphorinae, thirteen to Chrysomyiinae, ten to Lucilliinae and three to Toxotarsinae. The most abundant genus was the introduced *Chrysomya* (4.808 specimens) followed by the monotypic *Chloroprocta* (4.481 specimens) and the rarest was *Blepharicnema* (57 specimens). No specimens belongining to *Chrysomya rufifacies, Compsomyiops alvarengai*, *Compsomyiops boliviana*, *Compsomyiops melloi*, *Lucilia rognesi* and *Sarconesia maurii* previously reported for Northwest South America were found. One new species of *Lucilia* apparently endemic from the Amazonian region was found, and currently it is being describe by the senior author. A total of 729 geographical records were compiled (Figure 20), being those from the Andean region the most frequents and from the Tepuyan region the most scarse (Table 1). According the administrative units, Colombia was the country area with the highest number of records (442), followed by Ecuador (151), Venezuela (109), Northwest Brazil (92) and finally Northern Peru (3). Ecuador with 26 species and Colombia with 25 spp were the most diverse administratives-area, they share a high number of species and only one endemic species is reported for each; *Hemilucilia melusina* in Colombia and *Sarconesia maurii* in Ecuador.

Based in the regionalization here proposed the Andean region was the richest with 27 species, followed by Caribbean (17spp), Amazonian (14 spp), Pacific (10 spp), Orinoquia (8 spp), and the poorest; the Tepuyan region with only 5 species (Table 1). Likewise, the Andean region registered the highest number of endemic species, the Caribbean region recorded one endemic species, and the rest of the regions did not shown any endemism level (Table 1). The commented checklist, maps of distribution localities (Figures 3-19) and the altitudinal zonation (Figure 2) for 33 species are provided below.

Commented Checklist

Calliphoridae
Calliphorinae
Calliphora Townsend, 1908

Calliphora nigribasis Macquart, 1851
(Figures 2, 3)

This is a neotropical species occurring in the high elevations of the south American Andes. In Peru it was hemisynanthropic, reported as eurythermal collected from 1300 to 2650 m (Baumgartner & Greenberg, 1985). In the northern reaches the Páramo ecosystem along Ecuador, Colombia to Venezuela (Amat, Perez-Hoyos, Alvarez, *et al.*, In press.), absent in the Sierra Nevada de Santa Marta. We recorded it in the range of 2325 to 3380 m elevation (Figure 2), along intermediate elevations in the coastal range of Venezuela, and high elevations of the Andean region and where it displays a hemisynanthropic behavior (Amat, Perez-Hoyos, Alvarez, *et al* in press.; Baumgartner & Greenberg, 1985). The detailed morphological identification, taxonomy and historical nomenclature of this species may be consulted in Whitworth (2012). The immature stages were described by Florez & Wolff (2009) in Colombia and Greenberg & Szyska (1984) (as *C. peruviana*) in Peru.

Specimens examined. (20 males, 10 females) **Colombia** (17 males): (8 males) Antioquia, Belmira, El morro. 06°38'27.43"N; 75°40'19.84"W. 3127m, 13.ii.2012, F. Alvarez. H[abitat] P[áramo]. [T01]. V[an] S[omeren] R[ydon] mod[ificada], 72 h[ours] (CETdeA); (4 males) Belmira, Alto del rio, 06°40'9.42", 75°42'3.54", 2921m, (15-20).xii.2012, F. Alvarez, H[abitat] P[áramo], [T04], V[an] S[omeren] R[ydon] mod[ificada], [72 hrs], (CETdeA); (1 male) Boyacá, Villa de Leyva, Santuario de fauna y flora Iguaque, Lagunillas, 5° 41'00"N, 73°27'00"W, 3380m, 18.v.2001, Reina Pedro, H[abitat] P[áramo], M[alaise], IAvH110991 (IAVH); (1 male) Cundinamarca, Chia. 4° 51.211'N;74° 2.315'W. 2006-12-06. L. Torres Leg. Jama Sobre Cerdo. E. Amat det. 2010. IAvH110992 (IAVH); (1 male) same data except. IAvH110993; (1 male) Bogotá, Usaquen. 4° 41.834'N;74° 1.713'W. 1994-08-09. A. Segura. Manual. E. Amat det 2010. IAvH110989 (IAVH). (1 male) same data except. IAvH110990. **Ecuador** (2 males, 6 females); (1 male, 5 females,), Napo, Papallacta, 0°22’23.24” S, 78°8’22.35” O, 3376m, Oct 31,2015, M. Domínguez, V[an] S[omeren] R[ydon] mod[ificada] (QCAZ); (1 females), Tungurahua, 200876QCAZ, 200879QCAZ, 200880QCAZ, 200845QCAZ, Llanganates, -0.991041lat, 78.320057lon, 3342m, 25.ii.2015, S. Aguirre, Macphail mod[ificada] (QCAZ); (1 male), Same data, except 200846QCAZ, 24.ii.2015, -0.972605lat, 78.245627lon, (QCAZ). **Venezuela** (1 male, 4 females): (1 male, 1 female) Táchira, Betania, 2325m, Aug 7-8, 1972, J.B. Tera, J. Salcedo, (MIZA); (2 females) Same data, except Tachira via páramo El Tama, 2425m, March 16-20,1983, (MIZA); (1 female) Pico Naigata, 2765m, March 24, 1978, A. Montagne (MIZA).

Calliphora vicina Robineau-Desvoidy, 1830

(Figures 2, 3)

This is a widespread species including the Neotropical region (Whitworth, 2012), it was recorded in the low and intermediate elevations of southern South America (Chile and Argentina). Whitworth (2012) commented its high probability of occurrence in larger cities of this region. In the Northwest South America it was recorded mainly in anthropogenic environments of medium to large size of Ecuador and Colombia occupying high elevations of the Andean region (Figure 2). It was not recorded in Peru, Venezuela and Northwest Brazil neither in a recent survey of carrion flies of the Sierra Nevada de Santa Marta (Amat, Perez-Hoyos, & Rafael, in press.). Pinilla-Beltran, Segura, & Bello, (2012) reported it as synanthropic in Bogotá. Based on data gathered C. *vicina* seems to extend the elevation range upward as approaching the equator line. For detailed description and morphological see Rognes (1991); the identification of neotropical specimenes may follow rthe keys of Whitworth (2012). The life cycle of this species in the Andes was studied by Camacho (2005) and lately the immatures stages of European populations were studied with modern techniques of clearing larval tissue by Ubero-Pascal *et al.* (2012) .

Specimens examined. (11 males; 24 females) **Colombia.** (9 males, 8 females) **(**1 male) Boyacá. Tunja. 2860m. 2006-12-26. L. Amaya Leg. E. Amat Det.2015 (UPTC); (1 male) Boyacá, Paipa. 2006-11-26. Metodo directo. E. Amat Det.2014 (UPTC); (1 male) Boyacá. Tunja. P. Mondragon Leg. Colecta directa. E. Amat Det.2015 (UPTC); (2 males, 2 females) Boyacá. Paipa, 2512m, 2007-01-20. D. Rodriguez Leg.E. Amat Det.2015 (UPTC); (1 male) Boyacá. Tunja. UPTC.2750m. 2006-09-20 C. Rodriguez Leg. E. Amat Det.2015 (UPTC); (1 female) Boyacá. Duitama. Vereda La Parroquia. 2530m. 2007-11-01L. Martinez & M. Neira Trampa de caida Habitat Fragmentado Leg. E. Amat Det.2015 (UPTC); (1 female) Boyacá. Santa Rosa. 2500m. 2006-10-23. M. Gomez Leg. E. Amat Det.2015 (UPTC); (1 female) Boyacá. Duitama. Barrio San José.5°49'30,51'' N;73°01'35'56''W. 2516m. Colecta Manual. J. Lopez Leg. E. Amat Det.2015 (UPTC); (1 male, 1 female) Boyacá. Monquira. Vereda Coralina. E. Pinzon Leg. E. Amat Det.2015 (UPTC); (2 females) Boyacá. Tunja. UPTC. 05°32'N ;73°22'W. 2800m. J. Lopez & S. Perez Leg. E. Amat Det.2015 (UPTC); (1 male) Boyacá. Villa de Leyva. Casco Urbano 5.631327; -73.529483. 2200m .2005-06-20. Z. Reyes Red Entomologica. IAVH-110988. E. Amat Det.2012 (IAVH); (1 male) Cundinamarca. Bogotá. Usaquen. 2600m. 4.697373; -74.028693. 2004-08-09. A. Segura Leg. IAVH-110987. E. Amat Det.2012(IAVH). **Ecuador**. (2 males, 16 females); (1 female) Pichincha Quito, 1982-12, 00 09 S; 78 30 W, MECN-1 Dip-0866, leg. J.J. Espinosa, det E. Amat 2015 (MECN); (1 male) Pichincha, Quito, 2880m. 1983-05-21. D. Bastidas leg. B.E. Cooper det.1985. (QCAZ); (1 female) Pichincha, Quito. 1984-06-19. D. Bastidas Leg. MECN-1 Dip-0175. (MECN) (1 female) same data except MECN-1 Dip-0178 (MECN). (1 female) same data except MECN-1 Dip-0177 (MECN); (1male) Cotopaxi, Latacunga. 2768m. 2014-07-29. -0.9346055; -78.625241 W. Pruna Leg.; E. Amat det. 2015 (QCAZ). (1 female) Pichincha, Puerto Quito. 1983-04-23. Eleana Fegan Leg. E. Amat det. 2015 (QCAZ). (1 female) Pichincha, Quito. 2849m. 0 12 14.22 S; 78 30 31.41. 2011-04-09A. Zurita Leg. E. Amat det. 2015 (QCAZ). (1 female) Pichincha, Los Bancos. 0.02715; -78.89313 C. vera Leg. E. Amat det. 2015 (QCAZ). (1 female) Pichincha, Quito. 1992-06-29. R. Bernal Leg. Amat det. 2015 (QCAZ). (1 female) Pichincha.1982-12. A. Salazar Leg. E. Amat det. 2015 (QCAZ). (1 female) Pichincha, Quito. 2870m. J. Ortiz Leg. E. Amat det. 2015 (QCAZ); (1 female) Pichincha, Quito, 2810m, 2006-10-12, J. Mejia Leg. det E. Amat 2015 (QCAZ); (1 female) Cotopaxi, Moraspungo, 2011-03-05, Leg Nartieda 1 10 60 S; 79 12 0, Det. E. Amat 2015 (QCAZ); (1 female) Pichincha, Quito, Ponciano, -0,055482; -78,284909, 2820m, 2011-03-26, Leg. S. Ramirez Det. E. Amat 2015 (QCAZ); (3 females) Pichincha, Quito, Campus PUCE, 2800m. 2016-04-19. A. Barragan Leg.; Mc Phail modificada. E. Amat det. 2016 (QCAZ).

Chrysomyinae

Chloroprocta Wulp, 1896

Chloroprocta idioidea (Robineau-Desvoidy, 1830)

(Figures 2 ,4)

This is a widespread Neotropical species, in South America it occurs from southern United States to Paraguay (James 1970). In Peru it was common, particularly in low lands (rain forest) (Baumgartner & Greenberg, 1985). As in Colombia (Amat, 2009) and Venezuela reaches the foothills of the coastal range (Velásquez *et al* 2017). Recently it was reported as the most common species in the a surveys of necrophagous flies in Colombian and Brazilian Amazon (Amat *et al.*, 2016; Amat 2010; Esposito *et al* 2010). In the Northwest South America, this species occurs in the low lands of all natural regions except in the Tepuyan (Figure 4) in the range of 30 m to 1000 m high (Figure 2). It also was recorded in the proximities of the Venezuelan tepuis and with some isolated records at intermediate elevations in the foothills of central Andes in Colombia and Ecuador (Figure 4). Here we report it from Ecuador in the Andean and Amazon regions. It was not found in a recent survey of carrion flies of the Sierra Nevada de Santa Marta (Amat, Perez-Hoyos, & Rafael in press). According to our retrieved data and the recent literature *C. idioidea* tends strongly to the asynanthropic behaviour as in Peru (Baumgartner & Greenberg, 1985). The morphological identification based on coloration might be tricky; since Dear (1985) recognized a remarkable variation in coloration depending on the geographical distribution. Furthermore, in Peru Baumgartner & Greenberg (1985) detected two types of specimens differing in the size of anterior eyes facets. It is recommended to dissect the male terminalia to guarantee a reliable identification. For further detailed morphological description and taxonomical aspects see Dear (1985). Surprisingly the morphology of its immatures stages are unknown.

Specimens examined. (1.546 males, 2.935 females) **Brazil** (21 males 12 females) (1 male) Amazonas. Novo Airão. Rio Jau, Meriti. 1994-06-04, 1994-06-10. J. A. Rafael leg. E. Amat & A. Pérez det. 2017 (INPA); (1 female) Amazonas. Lago Amanã. 1979-09-21, Robin Best leg. E. Amat & A. Pérez det. 2017 (INPA); (1 male) Amazonas, Saõ Gabriel de Cachoeira Querari. 2 Pelotão de fronteira. 2 PEF. 0° 6'50.15"S; 67° 6'57.18"O. 1993-05-05; 1993-05-02. arm[adilha] Malaise. Motta C.S, Ferreira, R.L, Vidal, J & Matteo, B leg. 65751. E. Amat & A. Pérez det. 2017 (INPA); (3 males) Amazonas. Barcelos. Bacuquara. em Igarapé. 1° 1'37.13"S; 62°55'24.98"O. 2007-08. arm[adilha] Malaise. A.S. Filho & T Krolow leg. E. Amat & A. Pérez det. 2017 (INPA); (2 males) Same data, except, Bacuquara. lámina d´água. 0°09'09"N; 63°10'38" W. (INPA); (1 male) Same data, except. Em Campina. d´água de igarapé.1° 3'11.88"S; 62°53'41.17"O. 2007-07,08. A.S. Filho & T Krolow leg. arm[adilha] suspense-lámina. E. Amat & A. Pérez det. 2017 (INPA); (1 male 1 female) Same data, except. Serrinha. em floresta. 90m. 2007-07, 2007-08. arm [adilha] Malaise. A.S. Filho, T Krolow leg. E. Amat & A. Pérez det. 2017 (INPA); (4 males 3 females) Amazonas. Manaus. Estación investigación INPA. 2°35'19.98"S; 60° 6'59.44"O4. 2013-12, ZF2T03. V[an] S[omeren] R[ydon] mod[ificada]. Amat E, leg. E. Amat & A. Pérez det. 2014 (INPA); (1 female) Same data, except. C. Univica. 1988-06-23,30. arm[adilha] Shannon iscas Pezes. E. Binda & M-C. Castilho leg. E. Amat & A. Pérez det. 2017 (INPA); (1 female) Same data, except, INPA Campus II. 3° 5'47"S; 59°59'22"W. 1988-04-16. E. Amat & A. Pérez det. 2016 (INPA); (1 female) Same data, except, Reserva Florestal Adolpho Ducke. 1978-04-26. L.P. Alburqueque leg. E. Amat & A. Pérez det. 2017 (INPA); (1 male), Same data, except, 2014-07-18. RADT03. V[an] S[omeren] R[ydon] mod[ificada], E. Amat & A. Pérez leg. E. Amat & A. Pérez det. 2014 (INPA);(1 male) Roraima. Rio uraricoera. 1988-03-1,4. arm[adilha] Shanon. J.A. Rafael leg. E. Amat & A. Pérez det. 2017 (INPA); (2 males) Same data, except, Ilha de Maraca. 1987-05-2,13 (INPA); (1 male) Same data, except, 1987-05-21,30 (INPA); (3 males 3 females) Roraima. Caracarai. 1974-08-1. Campo (localidad) L.P. Alburqueque leg. E. Amat & A. Pérez det. 2017 (INPA); (1 female) Roraima. Caracarai. Rio Branco. 57m. 1974-08-01 L. P. Alburqueque leg. E. Amat & A. Pérez det. (INPA). **Colombia (**1.520 males 2.906 females). (2 males 4 females) Amazonas. La Chorrera. Camino Miguel. 1°27'30.75"S; 72°47'29.78"W. 185m. Zona 1 T01. 2015-04-27. T[rampa] V[an] S[omeren] R[ydon]. 72 h[oras]. Ever Kuiro leg. E. Amat & A. Pérez det. 2017 (CETdeA); (4 males, 4 females) Same data, except, Zona 1 T02 (CETdeA); (8 females) Amazonas. La Chorrera. Camino Nobe. 1°27'30.75"S; 72°47'29.78"W. 185m. Zona 2 T01. 2015-05-04. T[rampa] V[an] S[omeren] R[ydon]. 72 h[oras]. Ever Kuiro leg. E. Amat & A. Pérez det. 2017 (CETdeA); (1 male, 24 females) Same data, except, Zona 2 T02. (CETdeA); (6 females) Same data, except, Zona 2 T03 (CETdeA); (2 males 10 females) Same data, except, Zona 2 T04 (CETdeA); (2 males 7 females) Amazonas. La Chorrera. Camino Juan. 1°27'30.75"S; 72°47'29.78"W. 185m. Zona 3 T01. 2015-05-14 T[rampa] V[an] S[omeren] R[ydon]. 72 h[oras]. Ever Kuiro leg. E. Amat & A. Pérez det. 2017 (CETdeA); (1 male 2 females) Same data, except, Zona 3 T02. (CETdeA); (4 males 2 females) Same data, except, Zona 3 T03 (CETdeA); (7 males 3 females) Same data, except, Zona 3 T04 (CETdeA); (4 females) Amazonas. La Chorrera. Revalse. 1°27'30.75"S; 72°47'29.78"W. 185m. Zona 4 T03. 2015-05-24 T[rampa] V[an] S[omeren] R[ydon]. 72 h[oras]. Ever Kuiro leg. E. Amat & A. Pérez det. 2017 (CETdeA); (4 males 5 females) Same data, except, Zona 4 T04 (CETdeA); (1 male 49 females) Amazonas. La Chorrera. Camino Lago. 1°27'30.75"S; 72°47'29.78"W. 185m. 2015-06-27. Zona 5 T01. T[rampa] V[an] S[omeren] R[ydon]. 72 h[oras]. Ever Kuiro leg. E. Amat & A. Pérez det. 2017 (CETdeA); (1 male 69 females) Same data, except, Zona 5 T02 (CETdeA); (1 male 31 females) Same data, except, Zona 5 T03 (CETdeA); (3 males 31 females) Same data, except, Zona 5 T04 (CETdeA); (1 male 8 females) Amazonas. La Chorrera. Quebrada. 1°27'30.75"S; 72°47'29.78"W. 185m. 2015-06-02. Zona 6 T01 T[rampa] V[an] S[omeren] R[ydon]. 72 h[oras]. Ever Kuiro leg. E. Amat & A. Pérez det. 2017 (CETdeA); (9 females) Same data, except, Zona 6 T02 (CETdeA); (1 male 6 females) Same data, except, Zona 6 T03 (CETdeA); (2 males) Same data, except, Zona 6 T04 (CETdeA); (1 male 56 females) Amazonas. Mocagua. 3°49.265′S; 70°14.581′O 97m. 2013-11-27. Bosque primario. BP0102. T[rampa] V[an] S[omeren] R[ydon]. 72 h[oras]. E. Amat & Del L Aguila leg. E. Amat & A. Pérez det. 2015 (CETdeA); (1 female) Same data, except, 3°49.348′S; 70°14.509′O 122m. 2013-11-25. Bosque primario BP0201. T[rampa] V[an] S[omeren] R[ydon]. 72 h[oras]. Del L. Aguila leg. E. Amat & A. Pérez det. 2015 (CETdeA); (4 females) Same data, except, 3°49.348′S; 70°14.509′O 122m. 2013-11-27. Bosque primario. BP0202. Amat E & Del L Aguila leg. E. Amat & A. Pérez det. 2015 (CETdeA); (19 males 17 females) Amazonas. Carretera los kms, km5. 4°10.071′S; 69°56.651′O. 112m. 2013-09-22. Bosque secundario. BS0301 Del Aguila R, Perez J & Varela A leg. E. Amat & A. Pérez det. 2015 (CETdeA); (1 female) Amazonas. Carretera los kms, km7. 4°08.325′S; 69°56.396′O 123m. 2013-11-22. Claro. CL0101. T[rampa] V[an] S[omeren] R[ydon]. 72 h[oras]. Del R Aguila J. Perez & A. Varela leg. E. Amat & A. Pérez det. 2015 (CETdeA); (2 females) Amazonas. Leticia 4°12.537′S; 69°56.645′O. 81m. 2013-11-24. Urbano. UR0501. T[rampa] V[an] S[omeren] R[ydon]. 72 h[oras]. E. Amat leg. (CETdeA); (1 male) Amazonas, No data, 4:00:18 S; 59:54:45 W. 2007-12-04. Botella modificada y cebada con Cabeza de Pescado. Eduardo Amat Garcia & Luis Edier Franco Galeano leg. 1111672009. E. Amat det. 2009 (IAvH-E); (1 female) Amazonas. Río Igara Paraná. Chorrera La. 15 km. 0:44:0 S; 73:1:0 W. J. Idrobo & C. Saenz. Leg. (ICN MHN); (1 male) Caldas. Norcasia. Sector El Tigre. 05:38:59 N; 74:52:31 W. Fernando Forero leg. 111168. E. Amat det. 2009 (IAvH-E); (1 female) Caldas. Cañaveral. La Mula. 750m. E. Martinez leg. (MEFLG); (1 male 4 females) Chocó. Bahia Solano 06°15'55.0"; 77°27' 26.4". 63m. 2013-09-25. Plataneras. BSPLT04. V[an] S[omeren] R[ydon]. 72 h[oras]. J. Pérez, LM. Gomez & M. Quiroz leg. E. Amat & A. Pérez det. 2014 (CETdeA); (1 male 1 female) Same data, except, 06°15'57.0"; 77°27' 12.4'. 88m. 2013-09-25. Bosque. BSPLT08. E. Amat & A. Pérez det. 2014 (CETdeA); (46 males 158 females) Meta. San Martín. La Novilla. 03° 31’ 41.8’’; 73° 24’ 15.4’’. 249m. 2013-06-06. Bosque. LNBT02. T[rampa] V[an] S[omeren] R[ydon]. 72 h[oras]. J. Pérez & LM Gómez-Piñerez. leg. E. Amat & A. Pérez det. 2014 (CETdeA); (180 males 363 females) Same data, except, 03° 31’ 37.3’’; 73° 24’ 16.0’’249m. Bosque. LNBT03. (CETdeA); (121 males 255 females) Same data, except, 03° 31’ 35.0’’; 73° 24’ 17.2’’. 249m. Bosque. LNBT04. E. Amat & A. Pérez det. 2014 (CETdeA); (8 males 19 females) Same data, except, 03° 32’ 07.0’’; 73° 23’ 53.5’’. 262m. Potrero. LNPT06 (CETdeA); (99 males 101 females) Same data, except, 03° 32’ 08.9’’; 73° 23’ 53.1’’. Potrero. LNPT07. E. Amat & A. Pérez det 2014 (CETdeA); (53 males 60 females) Same data, except, 03° 32’ 11.2’’; 73° 23’ 59.7’’ 262m. Potrero. LNPT08. (CETdeA); (74 males 94 females) Same data, except, 03° 32’ 05.4’’; 73° 23’ 33.2’’ 256m. Sabana. LNST09. (CETdeA); (61 males 90 females) 03° 32’ 05.9’’; 73° 23’ 30.6’. 256m. LNST10. (CETdeA); (26 males 53 females) Same data, except, 03° 32’ 09.1’’; 73° 23’ 27.6’’ Sabana. LNST11. (CETdeA); (21 males 49 females) Same data, except, 03° 32’ 11.3’’; 73° 23’ 28.3’’. Sabana. LNST12. (CETdeA); (11 males 36 females) Same data, except, 03° 31’ 58.2’’; 73° 23’ 20.6’’. Moriche. LNMT15. (CETdeA); (1 male) Meta. Porvenir Marayal. 3:48 N; 73:49 W. 535m. 2002-04-03. Malaise H. Vargas leg. 111166. E. Amat det. 2009 (IAvH-E); (1 male) Same data, except, 111164. (IAvH-E); (1 female) Same data, except, 111163. (IAvH-E); (1 male) Same data, except, 111165. (IAvH-E); (1 female) Meta. Puerto Lopéz. Pachiaquiar. Finca El Saman. 4:3:37 N; 73:10:0 W. E. Amat & Z Reyes leg. (IAvH-E); (1 female) Guajira. Cerrejón. Campamento Mushaisa. 240m. 2000-05. M.Reyes leg. 111169. E. Amat det. 2009 (IAvH-E); (1 female) Risaralda. Pereira. La Suiza. 4:43:59 N; 75:34:59 W. 1827m. E. Manzano leg. (MPUJ); (1 male) Vichada. P.N.N El Tuparro. Cerro Tomas. 05:21 N; 67:51 W. 140m. 2001-05-22. Malaise. I.Gill leg. 111162. E. Amat det. (IAvH-E); (1 male) Same data, except, 2000-07-29. W. Villalba leg. 111160. (IAvH-E); (1 male) Same data, except, 111161. (IAvH-E); (1 female) Vichada. Cumaribo. Santa Rita. P.N.N El Tuparro. 5:18:27 N; 67:57:00 W. 35m. 2006-02-04. Trampa excremento humano. Ingrid Quintero & Elvia Gonzalez leg. 80648. E. Amat det. 2009 (IAvH-E); (3 males 1 female) Casanare. Tamara. San Pedro. 5°44'54.73"N; 72°12'55.09"W. 590m. 2016-05-17. Bosque PMT. PMT-B-VSRDip03. T[rampa] V[an] S[omeren] R[ydon] Mod[ificada]. 48 horas. L. E. Franco & F. Velandia leg. IAvH-ACF460. A. Perez & E. Amat det. 2016. (IAvH-E); (4 males 8 females) Same data, except, 5°45'10.13"N; 72°12'38.53"W. 570m. 2016-05-17. Pastizal PMT. PMT-Ptz-VSRDip03. IAvH-ACF470. 2016-05-17. (IAvH-E); (30 males 24 females) Casanare. Pore. La Plata. 5°34'13.50"N; 71°54'40.85"W. 204m. 2016-05-20. Bosque SBA. SBA-B- VSRDip01. T[rampa] V[an] S[omeren] R[ydon] Mod[ificada]. 48 horas. L.E. Franco & D. M. Pinto leg. IAvH-ACF473. A. Perez y E. Amat det. 2016. (IAvH-E); (12 males 16 females) Same data, except, SBA-B- VSRDip02. IAvH-ACF476. (IAvH-E); (327 males 661 females) Same data, except, SBA-B- VSRDip03. IAvH-ACF477 (IAvH-E); (20 males 27 females) Same data, except, 5°34'43.97"N; 71°54'26.01"W. 199m. Herbazal SBA. SBA-Hbz-VSRDip01. IAvH-ACF482 (IAvH-E); (12 males 11 females) Same data, except, SBA-Hbz-VSRDip02. IAvH-ACF485 (IAvH-E); (235 males 364 females) Same data, except, SBA-Hbz-VSRDip03. IAvH-ACF488 (IAvH-E); (51 males 66 females) Same data, except, 5°34'13.89"N; 71°54'7.79"W. 200m. Pastizal SBA. SBA-Ptz-VSRDip01. IAvH-ACF492 (IAvH-E); (25 males 30 females) Same data, except, SBA-Ptz-VSRDip02. IAvH-ACF495 (IAvH-E); (34 males 45 females) Same data, except, SBA-Ptz-VSRDip03. IAvH-ACF499 (IAvH-E). **Ecuador** (4 males 2 females). (1 female) Pichincha. Los Bancos.1000m. 2011-01-15. C. Vera leg. E. Amat det. 2015. (QCAZ-I); (4 males) Orellana. Estación Yasuni. 217m. 2012-04-05. LOC 02. T14A.C. León Leg. E. Amat det. 2015 (QCAZ-I); (1 female) Zamora CH. PN. Podocarpus. 04°09'35" S; 78°58'23"W. 1787m. 1998-10-03. L. Pozo & S. Noriega Leg. MECN 12314. MECN-1 Dip-0283Lote Cur 017. Trampa de intersección ING.MECN 98-09. E. Amat det. (MECN). **Venezuela** (1 male 1 female 14 females). (2 females) Amazonas. San Pedro de Cataniapo. 5,6086; -67,5958. 1000m. 1981-08-31. Trampa Malaise. J. L. Garcia leg. E. Amat det. (MIZA); (1 female) Aragua. El Limón. 450m. 1981-07-22. Cesar Giral leg. E. Amat det. (MIZA); (1 female) Aragua. Cumboto. 10,402072; -67,792366. 100m. 1999-11-25. J. L. Garcia & R. Montilla Trampa Malaise leg. E. Amat det. (MIZA); (2 females) Bolívar. Anacoco, Expedición La Salle. 6° 5' N; 61° 3' O. 1979-08-10, 1979-08-30. Expedición La Salle leg. E. Amat det. (MIZA); (2 females) Bolívar. Guri. 200m. 1998-07-06; 1998-06-27. L.J. Joly; J.L Garcia; Y Zavala leg. E. Amat det. (MIZA); (2 females) Same data, except, Trampa de intercepción. (MIZA); (1 female) Geremba. Vargas. PN Pico Codazzi. 2300m 1994-08-20. Luis. A. Campos leg. (MIZA); (1 female) Güarico. Hato las Lajas. 1966-06-24. F. Fernandez Y; A D Ascoli leg. E. Amat det. (MIZA); (1 male) Monagas. Uverito. P.M-Comedor abandonado. 1978-06-20. C.J. Rosales leg. Thomas det. (MIZA); (1 female) Portuguesa. Acarigua. La Miel 30 Km de Acarigua. 1951-06-23. P. Fenjes, Araujo leg. E. Amat det. (MIZA); (1 female) Sucre. 2 Km E. Mariquita. 1975-08-26. R. Dietz leg. E. Amat det. (MIZA); (1 female) Yaracuay. Yumare. 1970-03-3; 1970-03-09. J. Salcedo, C. Andara leg. E. Amat det. (MIZA).

Chrysomya Robinaeu-Desvoidy, 1830

Chrysomya albiceps (Wiedemann, 1830)

(Figures 2, 5)

One member of the introduced genus *Chrysomya*. This afro-European fly become widely distributed in Central and South America since its introduction in the seventies (Baumgartner & Greenberg, 1984). This species are commonly found in tropical low lands but can reach high elevations (3320m) in the Easter slope of the Peruvian Andes, being a eurythermal species (Baumgartner & Greenberg, 1985). Recently it was recorded at high altitudes (3375 m elevation) in the Páramo ecosystem of Ecuador (Amat, Perez-Hoyos & Alvarez, in press), in the costal cordillera and the Andes of Venezuela (Velásquez *et al.*, 2017). Furthermore, it was a common species in the Sierra Nevada de Santa Marta in the range of 300-400 m elevation (Amat, Perez-Hoyos, & Rafael in press). *C. albiceps* was the most common fly of the museums visited, based on the data gathered was clearly a eurythermal species inhabits from near the sea level to the 3000m elevation (Figure 2). In the Northwest South America occurs in all natural regions except in Tepuyan (Figure 5), it has not been collected in the pacific region of Colombia and Venezuelan Orinoquia. Hemisynantropic in Colombia and Peru (Baumgartner & Greenberg, 1985; Montoya-G *et al.*, 2009) although in the Sierra Nevada de Santa Marta tends to be synanthropic, and also common in the tropical dry forest and the premontane forest (Amat, Perez-Hoyos, & Rafael, in press). Additional aspects of the biology, ecology and bionomics of this species have been relatively well studied due to its medical and forensic importance. For morphological details and phenotypic polymorphism of neotropical specimens see Grella *et al.* (2015), the immature stages were studied by Florez and Wolff (2009).

Specimens examined. (718 males, 2401 females) **Brasil** (4 males, 23 females) (1 male, 5 females) Amazonas. Manaus. Campus Univ. Do Amazonas. 1999-11-05. Isca cachorro em putrefaçao. Leg. Alburqueque Jr., D.P. Det E. Amat & A. Pérez 2017 (INPA); (1 male, 2 females) Amazonas. Manaus. Campus Univiversitario, MAO. 1988-08-05, 1988-07-28. ArmShannon iscas Pezes. Leg. Marcia Castilho, J.Elias Binda. Det E. Amat & A. Pérez 2017 (INPA); (1 female) Amazonas. Manaus. C. Univica. 1988-07-07, 1988-06-30. Leg. E. Binda y

M-C. Castilho (INPA); (1 male) Amazonas. Manaus. Ilha Nacho nova. 1980-08-17. Leg. Nunes Mello. 5648. Det E. Amat & A. Pérez 2017 (INPA); (1 female) Amazonas. Manaus. INPA Campus II. 3° 5'47"S; 59°59'22"W 1980-10-10. Leg. B. Ulyssa. Det. E. Amat & A. Pérez 2017 (INPA); (5 females) Amazonas. Manaus. REMAN-SUL. 03°08'15"S a 19"; 59°57'21"W a 26".2006-10-27, 2006-09-14. Armadilla de Shannon data 2006-09-28. Leg. NO Aguilar; TL Gualerto, AW Gomes; MDM Raizer; ML Jurema. Det E. Amat & A. Pérez 2017

(INPA); (1 male, 9 females) Amazonas. Tefé. Campus Instituto Mamirauá. 2016-10. In dead Dolphin. Leg. D. Mendes Det. E. Amat & A. Pérez 2017 (INPA). **Colombia** (699 males, 2.295 females, 53 females) (3 females) Amazonas. Leticia. Carretera los kms, km5. 4°10.096′S; 69°56.563′O. 124m. 2013-11-22. BS0101. T[rampa] V[an] S[omeren] R[ydon]. 72 h[oras]. Leg. R. Del Aguila, J. Pérez & A. Varela. Det. E. Amat & A. Pérez 2014 (CETdeA); (1 female) Same data, except. 2013-11-24. BS0102. Leg. L. Gómez, E. Amat, R. Del Aguila, J. Pérez & A. Varela (CETdeA); (3 females) Same data, except. 4°10.071′S; 69°56.651′O. 112m. 2013-11-22. BS0301. Leg. R. Del Aguila, J. Pérez & A. Varela. (CETdeA); (1 female) Same data, except. 2013-11-24. BS0302 Leg. L. Gómez, E. Amat, R. Del Aguila, J. Pérez & A. Varela (CETdeA); (2 males, 1 females) Same data, except. 4°10.095′S; 69°56.621′O. 110m. 2013-11-22. BS0401. Leg. R. Del Aguila, J. Pérez & A. Varela. (CETdeA); (1 female) Same data, except. 4°10.113′S; 69°56.591′O. 104m. 2013-11-22. BS0501. Leg. R. Del Aguila, J. Pérez & A. Varela. (CETdeA); (1 female) Same data, except. 2013-11-24. BS0502. Leg. L. Gómez, E. Amat, R. Del Aguila, J. Pérez & A. Varela (CETdeA); (1 male, 1 female) Amazonas. Leticia. Carretera los kms, km7. 4°08.325′S; 69°56.396′O 123m. 2013-11-22. CL0101. Leg. L. Gómez, E. Amat, R. Del Aguila, J. Pérez & A. Varela (CETdeA); (1 male, 1 female) Same data, except. 4°08.241′S; 69°56.270′O. 115m. CL0401. (CETdeA); (1 male) Same data, except. 2013-11-24. CL0402. (CETdeA);(2male, 11females) Amazonas. Leticia. 4°13.024′S; 69°56.468′O. 79 m. 2013-11-22. UR0101. Leg. A. Varela (CETdeA); (8 males, 18 females) Same data, except. 2013-11-24. UR0102 (CETdeA); (4 females) Same data, except. 153m. 4°13.088′S; 69°56.471′O. 2013-11-22. UR0301.Leg. J. Pérez & A. Varela (CETdeA); (1 male, 13females) Same data, except. 2013-11-24. UR0302. Leg. J. Pérez & A. Varela (CETdeA); (2 males, 4 females) Same data, except. 4°12.669′S; 69°56.546′O. 154m. 2013-11-24. UR0402 (CETdeA); (46 males, 97 females) Same data, except. 81m. 4°12.537′S; 69°56.645′O. Leg. E. Amat. UR0501

(CETdeA); (19 males, 29 females) Same data, except. 2013-11-26. UR0502. (CETdeA);(154 males, 246 females) Same data, except. 4°13.024′S; 69°56.468′O. 79m. 2013-11-27. UR0602. (CETdeA); (14 males, 101 females) Antioquia. Medellín. Pajarito. 06º17'10.7"N; 75º36'43.7"W. 1915m. 2010-03-10. 3P1. T[rampa] V[an] S[omeren] R[ydon]. 72 h[oras]. Leg. M. Ramírez Det. M. A. Ramírez (CETdeA); (26 males, 50 females) Antioquia. Caldas. La Clara. 1840m. 06º03'06.9"N; 75º37'19.2"W. 2010-02-09. 2C2. Leg. M.A. Ramírez, J. Durango, H. Areiza (CETdeA); (5 females) Antioquia. Medellín. Cola del Zorro. 06º12'19.7"N; 75º32'43.9"W.1943m. 2010-02-07. 2CZ1. (CETdeA); (4 females) Antioquia. Medellín. Copacabana. Ankon. 1417m. 06º22'07.1"; 75º29'22.3". 2CP1. TdeA 844. (CETdeA); (1 females) Antioquia. Medellín. Universidad Nacional de Colombia. 2007-03-03. Trampa de carroña Fish head. Leg. E. Amat. Det. E. Amat 2009. 111202. (IAVH-E); (1 female) Boyacá. Moniquirá. Vereda Carolina. Colecta directa. Leg. E. Pinzón (UPTC); (1 female) Boyacá. Sáchica. Centro. 05° 41’26’’N; 73°26’07’’ W. 2012-10-02. Leg. J. Pérez (UPTC); (1 female) Boyacá. San Luis de Gaceno. Vereda El Cairo. 2011-05-16. (UPTC); (1 female) Caldas. Cañaveral. La Mula. 750m. Leg. E. Martínez (MEFLG); (19 females) Casanare. Tamara. San Pedro. 5°45'26.35"N; 72°12'45.00"W. 560m. 2016-05-17. PMT-BdG-VSRDip01. T[rampa] V[an] S[omeren] R[ydon]. 72 h[oras]. Leg. L.E. Franco & F. Velandia. Temp-ACF448. Det A. Pérez & E. Amat 2016 (IAvH-E); (6 females) Same data, except. PMT-BdG-VSRDip02. Temp-ACF452. (IAvH-E); (1 females) Same data, except. PMT-BdG-VSRDip03. Temp-ACF453 (IAvH-E); (2 males, 2 females) Same data, except. 5°44'54.73"N; 72°12'55.09"W. 590m. PMT-B-VSRDip02. Temp-ACF456 (IAvH-E); (3 females) Same data, except. PMT-B-VSRDip03. Temp-ACF459 (IAvH-E); (13 females) Same data, except. 5°45'10.13"N; 72°12'38.53"W. 570m. PMT-Ptz-VSRDip01. Temp-ACF461 (IAvH-E); (3 males, 4 females) Same data, except. PMT-Ptz-VSRDip02. Temp-ACF464 (IAvH-E); (26 males, 138 females) Same data, except. Temp-ACF467. PMT-Ptz-VSRDip03 (IAvH-E); (6 males, 1 female) Casanare. Pore. La plata. 5°34'13.50"N; 71°54'40.85"W. 204m. 2016-05-20. SBA-B- VSRDip01. Leg. L.E. Franco & D.M. Pinto. Temp-ACF471 (IAvH-E); (4 males, 2 females) Same data, except. SBA-B- VSRDip02. Temp-ACF474 (IAvH-E); (11 males, 30 females) Same data, except. SBA-B- VSRDip03. Temp-ACF478 (IAvH-E); (3 males, 18 females) Same data, except. 5°34'43.97"N; 71°54'26.01"W. 199m. Temp-ACF481. SBA-Hbz-VSRDip01 (IAvH-E); (3 females) Same data, except. SBA-Hbz-VSRDip02. Temp-ACF484

(IAvH-E); (11 males, 31 females) Same data, except. SBA-Hbz-VSRDip03. Temp-ACF487 (IAvH-E); (8 males, 12 females) Same data, except. 5°34'13.89"N; 71°54'7.79"W. 200m. SBA-Ptz-VSRDip01. Temp-ACF491 (IAvH-E); (13 males, 49 females) Same data, except. SBA-Ptz-VSRDip02. Temp-ACF494 (IAvH-E); (2 males, 1 females) Same data, except. SBA-Ptz-VSRDip03. Temp-ACF498 (IAvH-E); (9 females) Cundinamarca. Bogotá. Universidad Nacional. 4º38´31.71´´; 74º04´54.02´´. 2560m. 2014-03-30. T[rampa] V[an] S[omeren] R[ydon]. 72 h[oras]. UNBOG0201. Leg. J. García. & E. Ariza Det. E. Amat & A. Pérez 2014 (CETdeA); (21 females) Same data, except. 2014-04-01. UNBOG0202 (CETdeA); (8 males, 30 females) Same data, except. 2014-05-9, 2014-05-12. UNBOG0301 (CETdeA); (12 males, 76 females) Same data, except. 2014-05-19, 2014-05-22. UNBOG0302 (CETdeA); (5 males, 46 females) Same data, except. 2014-06-13, 2014-06-16. UNBOG0401 (CETdeA); (5 males, 33 females) Same data, except. 2014-06-24. UNBOG0402 (CETdeA); (15 males, 64 females) Same data, except. 2014-07-05, 2014-07-28. UNBOG0501 (CETdeA); (2 males, 51 females) Same data, except. 2014-08-01, 2014-08-04. UNBOG0502 (CETdeA); (1 male) Cundinamarca. Usaquén. 04° 44’25.32’’N; 74°1’46.40’’ W. 2600m. 2004-07-26. Colecta Manual. Leg. A. Segura. 111199. Det. E. Amat 2009 (IAVH-E); (1 male) Cundinamarca. La Mesa. 2002-12-18. 54472 E. Amat 2009 (IAVH-E); (1 female) Same data, except. 4.638790; -74.462546. 1135m. 2002-12-18. 54473 (IAVH); (1 female) Same data, except. El Espino. 04° 38’09’’N; 74°27’59’’ W. Leg. JJW (IAVH-E); (1 female) Cundinamarca. Caqueza. Vda. Ubatoque. 1476m. Leg. L. Moreno (ICN MHN); (1 female) Cundinamarca. Mosquera. Corpoica - Tibaitata. 4.697361; -74.204564. 2543m. Leg. G. Camacho & F. Ospina (ICN MHN); (1 female) Magdalena. Santa Marta. Cincinati. 11° 6'6.94"N; 74° 4'52.69"W. 1427m. 2013-03-02. SMT 02. T[rampa] V[an] S[omeren] R[ydon]. 72 h[oras]. Leg. E. Amat, G. Utria, & P. Sepúlveda Det. E. Amat & A. Pérez 2013 (CETdeA);(31 males, 282 females) Magdalena. Santa Marta. Las Tinajas. 11°15'30.50"N; 74° 4'32.80"W. 388m. 2013-03-03. SMT 09 T[rampa] V[an] S[omeren] R[ydon]. 72 h[oras]. Leg. E. Amat, G. Utria, & L. Pérez. Det. E. Amat & A. Pérez 2013 (CETdeA); (8 males, 26 females) Same data, except. 11°15'14.60"N; 74° 4'25.80"W. 390m. SMT 10 (CETdeA); (10 males, 31 females) Same data, except. 11°14'54.50"N; 74° 4'3.00"W 337m. SMT 11 (CETdeA); (1 male, 5 females) Magdalena. Santa Marta. Minca. 11° 8'34.20"N; 74° 6'31.50"W. 768m. 2013-03-02. SMT 05. T[rampa] V[an] S[omeren] R[ydon]. 72 h[oras].

Leg. E. Amat, G. Utria, & P. Sepúlveda. Det. E. Amat & A. Pérez 2013 (CETdeA); (8 males, 29 females) Same data, except. 7'57.20"N; 74° 7'7.80"W. 708m. SMT 06. Leg. E. Amat, G. Utria, & L. Pérez (CETdeA); (5 males, 188 females) Same data, except. 11° 9'22.30"N; 74° 8'7.80"W. 465m. SMT 07 (CETdeA); (1 female) Same data, except. 2013-02-03. 14865 (CBUMAG); (1 female) Same data, except. 4866 (CBUMAG); (28 males, 42 females) Magdalena. Santa Marta. Palangana. 11°16'23.10"N; 74° 9'30.80"W. 195m. 2013-03-03. SMT 13. T[rampa] V[an] S[omeren] R[ydon]. 72 h[oras]. Leg. E. Amat, G. Utria, & L. Pérez. Det. E. Amat & A. Pérez 2013 (CETdeA); (17 males, 6 females) Same data, except. 11°16'14.40"N; 74° 9'24.30"W. 153m. SMT 14 (CETdeA); (8 males, 21 females) Same data, except. 11°15'55.00"N; 74° 9'23.90"W. 180m. SMT 15 (CETdeA); (13 males, 48 females) Same data, except. 11°15'35.00"N; 74° 9'33.40"W. 145m. SMT 16 (CETdeA); (8 males, 3 females) Magdalena. Santa Marta. Finca Libano 2000. 11°12'42.83"N; 74°10'12.99"O. 2016-03-23. T01. T[rampa] V[an] S[omeren] R[ydon]. 72 h[oras]. Leg. Palmera & Miranda. Det. E. Amat & A. Pérez 2016 (CETdeA); (35 males, 46 females) Magdalena. Santa Marta. Universidad del Magdalena. 11°13'19.74"S; 74°11'12.29"O. 2016-03-23. T[rampa] V[an] S[omeren] R[ydon]. 72 h[oras]. T02. Leg. Palmera & Miranda. Det. E. Amat & A. Pérez 2016 (CETdeA); (4 males, 44 females) Same data, except. 20m. 2013-03-04 SMT 17. Leg. E. Amat, WOT. 72 h[oras]. G. Utria, & P. Sepúlveda. Det E. Amat & A. Pérez 2013 (CETdeA); (1 male, 4 females) Magdalena. Santa Marta. Mamatoco. Cementerio jardines de paz. 2016-03-29. T03. T[rampa] V[an] S[omeren] R[ydon]. 72 h[oras]. Leg. Palmera & Miranda Det. E. Amat & A. Pérez 2016 (CETdeA); (54 males, 175 females) Magdalena. Santa Marta. Vira Vira. 11°14'9.80"N; 74° 4'17.00"W. 259m. 2013-03-03. SMT 12. T[rampa] V[an] S[omeren] R[ydon]. 72 h[oras]. Leg. E. Amat, G. Utria, & L. Pérez. Det. E. Amat & A. Pérez 2013 (CETdeA); (1 female) Magdalena. Santa Marta. Finca Kalashe-Kalabia. 11°16,498" N; 74°05,829 O. 143m. 2008-05-02. Leg. E. Perdomo & C. Valverde. 5932. Det Paula Sepúlveda (CBUMAG); (1 female) Same data except 2008-02-02. 5967 (CBUMAG); (1 female) Same data except 5970 (CBUMAG); (1 female) Same data except 5966 (CBUMAG); (1 female) Same data except 5971 (CBUMAG) (1 female) Same data except 2008-02-01. 5962 (CBUMAG); (1 female) Same data except 5968 (CBUMAG); (1 female) Same data except 2008-04-02. 7600 (CBUMAG);(1 female) Same data except 7628 (CBUMAG);(1 female) Same data except 7629 (CBUMAG); (1 female) Same data except 7604 (CBUMAG); (1 female) Same data except 7605 (CBUMAG); (1 female) Same data except 7630 (CBUMAG); (1 female) Same data except 1945 (CBUMAG); (1 female) Same data except 5964 (CBUMAG); (1 female) Same data except 7652 (CBUMAG); (1 female) Same data except 2008-01-23. 5906 (CBUMAG); (1 female) Same data except 1925 (CBUMAG); (1 female) Same data except 2073 (CBUMAG); (1 female) Same data except 6028 (CBUMAG); (1 female) Same data except 6027 (CBUMAG); (1 female) Same data except 2133 (CBUMAG);(1 female) Same data except 6026 (CBUMAG); (1 female) Same data except 6024 (CBUMAG);(1 female) Same data except 2008-01-28. 5909 (CBUMAG); (1 female) Same data except 1951 (CBUMAG);(1 female) Same data except 2008-01-24. 7651 (CBUMAG); (1 female) Same data except 5998 (CBUMAG); (1 female) Same data except 5997 (CBUMAG); (1 female) Same data except 5999 (CBUMAG); (1 female) Same data except 5910 (CBUMAG); (1 female) Same data except 2008-01-31. 5963 (CBUMAG; (1 female) Same data except 5965 (CBUMAG);(1 female) Same data except 2008-01-22. 1932 (CBUMAG); (1 female) Same data except 2008-01-25. 2059 (CBUMAG);(1 female) Same data except 2008-02-31. 6001 (CBUMAG); (1 female) Same data except 6005 (CBUMAG); (1 female) Same data except 6002 (CBUMAG); (1 female) Same data except 6000 (CBUMAG); (1 female) Same data except 5996 (CBUMAG); (1 female) Same data except 6004 (CBUMAG); (1 female) Same data except 5600 (CBUMAG); (1 female) Same data except 2008-02-21. 5969 (CBUMAG); (2 females) Meta. San Martin. La Novilla. 03° 31’ 41.8’’; 73° 24’ 15.4’’. 249m. 2013-06-06. LNBT02 T[rampa] V[an] S[omeren] R[ydon]. 72 h[oras]. Leg. J. Pérez & L Gómez-P Det. E. Amat & A. Pérez 2013 (CETdeA); (2 males, 3 females) Same data except LNBT03 (CETdeA); (4 females) Same data except LNBT04 (CETdeA); (1 male) Same data except LNPT05 (CETdeA); (7 males, 10 females) Same data except 03° 32’ 08.9’’; 73° 23’ 53.1’’. 262m. LNPT07 (CETdeA); (1 male, 1 female) Same data except LNPT08 (CETdeA); (3 males, 9 females) Same data except 03° 32’ 05.4’’; 73° 23’ 33.2’’. 256m. LNST09 (CETdeA); (11 males, 12 females) Same data except 03° 32’ 05.9’’; 73° 23’ 30.6’. LNST10 (CETdeA); (2 males, 2 females) Same data except 03° 32’ 09.1’’; 73° 23’ 27.6’’. LNST11 (CETdeA); (2 males, 2 females) Same data except 03° 32’ 11.3’’; 73° 23’ 28.3’’. LNST12 (CETdeA); (10 males, 10 females) Same data except 03° 32’ 00.2’’; 73° 23’ 21.0’’. LNMT13 (CETdeA); (1 female) Same data except 03° 31’ 59.3’’; 73° 23’ 21.7’’. 244m. LNMT14 (CETdeA);(9 males, 17 females) Same data except 03° 31’

58.2’’; 73° 23’ 20.6’’. LNMT15 (CETdeA); (2 males, 1 female) Same data except 03° 31’ 59.2’’; 73° 23’ 19.0’’. LNMT16 (CETdeA); (1 female) Meta. Puerto López. Pachaquiaro. Finca El Samán. 2006-11-03. Leg. E. Amat & Z. Reyes. 111381 Det. E. Amat 2009 (IAVH-E); (1 female) Same data except 111382 (IAVH); (1 female) Same data except 111378 (IAVH-E); (1 female) Same data except 111380 (IAVH-E); (1 female) Same data except111379 (IAVH-E); (1 female) Meta. San Martín. Finca El Caduceo. 3.6944; -73.6936. 450m. 2005-12-18. Leg. E. Amat. 111204 Det. E. Amat 2009 (IAVH-E); (1 female) Same data except 111207 (IAVH-E); (1 female) Same data except 111392 (IAVH-E); (1 male) Same data except 111205 (IAVH-E); (1 female) Same data except 111203 (IAVH); (1 male) Same data except 111206 (IAVH-E); (1 female) Vichada. Cumaribo. Santa Rita. Leg. I. Quintero & E. González. 135m. Det. E. Amat 2009 (IAVH-E); (1 female) Same data except Entomológico Trampa excremento humano. 2004-01-30. 111201 (IAVH-E); (1 male) Same data except 2004-02-18. Entomológico Trampa de intercepción de vuelo. 111200. (IAVH-E). **Ecuador** (15 males, 25 females) (3 males) Galapagos. San Cristobal. El chino. 0°55'29.21; 89°27'5.1"W. 2249m. 15-2002. Leg. L.Guamá Det. E. Amat 2015 (QCAZ-I); (3 males, 3 females) Pinchica. Jerusalen. 2014-06-31. Leg. S.Aguirre. Det. E. Amat 2015 (QCAZ-I); (5 males, 2 females) Pinchicha. Machachi. 2944m. 2014-02-20. Leg. A. Barragán Det E. Amat 2015 (QCAZ-I); (2 females) Same data except 2013-03-13. Leg. S.Aguirre (QCAZ-I); (1 females) Pinchicha Nayón. 0°10.5763"N; 78°25.666"W. 2397m. 2013-10-25. Leg. S. Aguirre. Det.E. Amat 2015 (QCAZ-I); (1 female) Same data except2013-10-02. Leg. M. (no se entiende la etiqueta) (QCAZ-I); (1 female) Same data except 2013-10-25. M. (no se entiende la etiqueta) (QCAZ-I); (3 males, 12 females) Same data except 2014-07-16. Leg. S.Aguirre (QCAZ-I); (2 females) Pinchicha. Quito. 2800m. 2013-09-05. Leg. S.Aguirre. Det. E. Amat 2015 (QCAZ-I); (1 male) Esmeraldas. Tonsupa. 0m. 2013-04-09. Leg. D.Navarrete. Det. E. Amat 2015 (QCAZ-I); (1 female) Same data except 2400m. 2012-04-20. Leg. M.Stancey (QCAZ-I). **Venezuela** (5 females) Miranda. Los Salias. Altos de Pipe IVIC.10°24'5"N; 66°58'37"W.1600m.-1700m. Det. Arianna Thomas (MIZA).

***Chrysomya megacephala* (Fabricius, 1794)**

(Figures 2, 6)

One of the exotic species that was introduced decades ago and then widely spread in neotropical environments. In Brazil it expanded slower than the rest of the introduced *Chrysomya* spp (Baumgartner & Greenberg, 1984). The same authors mentioned that no barrier existed for the northward spread of this species. shortly after it was recorded in the eastern Andes of Venezuela (Baumgartner, 1988), then in Colombia (Barreto, Burbano, & Barreto, 2002) and the low lands of the Colombian Caribe, including insular records (Amat, 2009) and the Galapagos in Ecuador (Tantawi & Sinclair, 2013). Probably the current northern populations are the result of different introductions events to those described in Brazil. Recently it was abundantly collected near to the sea level at base of the Sierra Nevada de Santa Marta (Amat, Perez-Hoyos, & Rafael in press) and recorded in the coastal cordillera of Venezuela (Velásquez *et al.*, 2017). In the Northwest South America, it occurs in all natural regions except in the Orinoquia and Tepuyan (Figure 6) it was recorded from near to the sea level to 2400m (Figure 2). It seems to be eurythermal species since some populations were recorded at intermediate and high elevations of the central Andes. In the foot hills of the Andes it is Eusynanthropic (SI= +96) (Montoya-G *et al.*, 2009) as in the Caribe (SI= +98) (Amat, Perez-Hoyos, & Rafael in press). The bionomical and ecological aspects have been relatively well studied due to its medical and forensic importance, some basic aspects of its biology were treated by Greenberg (1973). For its morphological description and identification of neotropical specimens see the key of Grella *et al.* (2015), the immature stages were studied by Florez & Wolff (2009).

Specimens examined. (228 males, 573 females) **Brasil** (3 males, 3 females): **(**1 male) Manaus. INPA Campus II. 3° 5'47"S; 59°59'22"W. 2008-01-03. Souza A.B leg. Souza A.B det. (INPA); (1 female) Same data, except, Tiradentes. 3° 4'37.43"S; 59°58'34.55"W. 1988-04-25, Machado L.C leg. E. Amat det 2015. (INPA); (1 female) Same data, except, Feira da Compesa. 3° 6'19.34"S; 60° 3'27.38"W. 2001-08-20. Ale-Rocha. R. & Soares. E. F leg. E. Amat det 2015 (INPA); (1 male) Same data, except, Feira do Coroado. 3° 5'1.42"S; 59°58'48.04"W, 2001-08-17, Ale-Rocha. R. & Soares. E. F leg. E. Amat det 2015 (INPA); (1 female) Same data, except, Mercado Municipal, 3° 7'28.44"S; 59°59'40.89"W. 2001-08-30. Ale-Rocha. R. & Soares. E. F leg. E. Amat det 2015 (INPA); (1 male) Same data, except, INPA V8. 1989-01-26. N.D. Paraluppi leg. E. Amat det 2015. (INPA).

Colombia (208 males 537 females): (2 males, 8 females) Amazonas. Leticia, 4°13'0.24"S; 69°56'4.68"W. 79m. 22.xi.2013-11-22. V[an] S[omeren] R[ydon] mod[ificada]. Varela A leg. A. Pérez det. 2014 (CETdeA); (1 female) Same data, except. Carretera los Kms. Km 7. 4° 8'14.46"S; 69°56'16.20"W. 115m. 2013-11-22. CL0401. Del Águila R, Pérez J & Varela A leg A. Pérez det. 2014 (CETdeA); (1 male), Same data, except, Carretera los Kms. Km 5. 4°10'5.76"S; 69°56'33.78"W. 124m. BS0101. (CETdeA); (1 male, 2 females) Same data, except. Mocagua. 3°49'12.06"S; 70°14'6.66"W. 80m. 2013-11-25. BP0401. Del Águila R. leg. (CETdeA); (1 female) Antioquia. Caldas. La Clara. 06º03'06.9"N; 75º37'19.2"W. 1840m. 2010-02-07. 2C1. V[an] S[omeren] R[ydon] mod[ificada] Manuel Alejandro Ramirez, Jessica Durango & Hernan Areiza leg. TdeA 603. Alejandro Ramirez det. (CETdeA); (8 males,4 females) Antioquia. Copacabana. Relleno sanitario curva de rodas. 648m. J. Pulgarin leg E. Amat det. 2012 (MEFLG); (1 male), Same data, except. Ankon, 06º22'07.1"N; 75º29'22.3"W. 1417m. 2010-02-09. 2CP2. V[an] S[omeren] R[ydon] mod[ificada]. Manuel Alejandro Ramírez, Jessica Durango & Hernan Areiza leg. TdeA 765. Alejandro Ramirez det. (CETdeA); (1 male), Antioquia. Medellín. Cola del Zorro. 06º12'19.7"N; 75º32'43.9"W. 1943m. 2010-02-07. 2CZ1. Manuel Alejandro Ramírez, Jessica Durango & Hernán Areiza. Leg. TdeA 668. V[an] S[omeren] R[ydon] mod[ificada]. Alejandro Ramirez det. (CETdeA); (1 female) Antioquia. Medellín. Universidad Nacional de Colombia, 6°15'37.09"N; 75°34'34.27"W. 2006-04-18. Trampa de carroña. Gómez Pieneres Luz Miryam leg. 111196. E. Amat det. 2013 (IAvH-E); (1 female) Same data, except, 111198. (IAvH-E); (9 males, 19 females) Bolívar. Archipiélago de San Bernardo. Isla Múcura. 10m. 2004-01-05. Manual E. Amat & C. Flórez leg. E. Amat det. 2013 (IAvH-E); **(**1 male, 5 females) Boyacá. Villa de Leyva. Centro Vereda. 5° 38'19"S; 73°31'42"W. 2400m. 2005-04-24. Manual. Z. Reyes leg. 111189. E. Amat det. 2013 (IAvH-E); (1 female) Boyacá. Villa de Leyva. Claustro San Agustín. 5°38'3.35"N; 73°31'12.63"W. 2200m. 2013-05-03. E. Amat, Manual leg. 111192. E. Amat det. 2013 (IAvH-E); (1 female) Caldas. Cañaveral. La Mula. 380m. E. Martínez leg. E. Amat det. 2012 (MEFLG); **(**1 male 6 females) Chocó. Bahía Solano. Playa Huina, 06°16' 13.1" N; 77°27' 25.9" O; 53m. 2013-11-25. BSUT13. V[an] S[omeren] R[ydon] mod[ificada]. Pérez J, Gómez LM & Quiroz. A. Pérez det. 2013 (CETdeA); (1 female) Guajira. Cerrejón. Campamento Mushaisa. 240m. 2005-06. Manual. M. Reyes leg. 111194. E. Amat det. 2013 (IAvH-E); (1 male) Same data except 111193 (IAvH-E); (1 female) Huila. Neiva. Parque de los periodistas. 2°55'39.73"N; 75°16'48.41"W. 2007-06-12. Manual. E. Amat leg. 111191. E. Amat det. 2013 (IAvH-E); (1 female) Magdalena. Fundación. Hacienda la alcahueta. 2m. 2010-11. Jama. Movilla, B leg 265. Paula Sepúlveda det. (CBUMAG); (1 female) Magdalena. Santa Marta. Finca Kalashe-Kalabia. 143m. 2008-01-30. Cerdo sol. Perdomo. E. & Valverde. C. leg. 1967. Paula Sepúlveda det. (CBUMAG); (1 female) Same data except 2008-01-24. 5988. (CBUMAG); (23 males 72 females) Same data except Finca Libano 2000. 2016-02-23. TO1. V[an] S[omeren] R[ydon] mod[ificada]. Palmera & Miranda. A. Pérez det. 2016 (CETdeA); (1 female) Same data except Galixia. 22m. 2010-05. Celedón. G leg. 266. Paula Sepúlveda det (CBUMAG); (4 males 8 females) Same data except Mamatoco. Cementerio jardines de paz. 11º13´52.29´´; 74º10´13.93´´; 2016-03-29. T03. V[an] S[omeren] R[ydon] mod[ificada]. Palmera & Miranda leg, A. Pérez det. 2016 (CETdeA); (1 female) 260, Same data except Sector Bonda. 67m. 2011-04-17. O. Matos. & M. navarro leg. Paula Sepúlveda det (CBUMAG);(1 female) Same data except Universidad del Magdalena, 11°13'19.74"S; 74°11'12.29"O. 2013-03-04 V[an] S[omeren] R[ydon] mod[ificada]. E Amat, G Utria. & P Sepúlveda. leg. 4867. (CBUMAG); (1 female) Same data except 4868. (CBUMAG); (77 males 220 females) Same data, except. 2016-03-23. T02. Palmera & Miranda leg. Pérez det. 2016 (CETdeA); (56 males 122 females) Same data, except. 2013-03-04, SMT 17. WOT. Amat, E. Utria, G & Sepúlveda P A. leg. A. Pérez & E. Amat det. 2013 (CETdeA); (5 males 11 females) Same data except Las Tinajas. 11°15'30.50"N; 74° 4'32.80"W. 388m. 2013-03-03. T09. E. Amat, G Utria, & L Perez leg. (CETdeA); (1 male) Same data except Minca. 11° 9'22.30"N; 74° 8'7.80"W. 465m. 2013-03-02. STM 07. (CETdeA); (15 males 33 females) Same data except Palangana. 11°16'23.10"N; 74° 9'30.80"W. 195m. 2013-03-03. SMT 13. (CETdeA); (1 male) Same data except Vira Vira. 11°14'9.80"N; 74° 4'17.00"W. 259m. SMT 12. (CETdeA); (1 female) Same data except P.N.N.T, Bahía Concha. 0m. 2013-04-09. Jama. D. Sánchez, L. Alcántar. & C. Cuervo leg. (UPTC); (10 females) Same data except Diurno. Colecta directa. F. Verdugo. & Casas. L Pineda leg. (UPTC); (1 female) Same data except Playa Neguanje. 11m. A. Leguizamo leg (UPTC). **Ecuador** (3 males, 1 female,): (3 males) Los Ríos. Babahoyo. 1°48'15.60"S; 79°31'44.20"W. 10m. 2013-11-12. L. Bermúdez leg. E. Amat det. 2015 (QCAZ-I); (1 female) Sucumbíos. Lumbaqui. 0° 2'57.19"N; 77°19'45.80"W. 2013-04-01, M.A. Jurado leg. E. Amat det. 2015 (QCAZ-I). **Venezuela** (14 males, 32 females) **(**1 female) Anzoategui. Anaco. E. Amat det. 2015 (MIZA); (1 male) Aragua. El

Limón. 450m. 9.85; -66.9. 1980-12-03. F. Fernández leg. E. Amat det 2004 (MIZA); (2 males) Same data except 1981-07-28. Cesar Giral leg. (MIZA); (1 male) Same data except 1972-06-25; 1972-06-26. (MIZA); (12 females) Aragua. Maracay. 450m. 1990-08-03. R.D. Tovar leg. E. Amat det 2015 (MIZA); (1 female) Aragua. Pozo Diablo. Carretera Maracay. 10°17'49.75"N; 67°36'3.81"O. 500m. 1950-11-24. F. Fernández. Y. leg. E. Amat det 2015 (MIZA); (1 female) Aragua Rancho Grande. PN Henri Pittier. 1100m. 1981-05-15. E. Amat det 2015 (MIZA); (1 male) Carabobo. Valencia. Cerro el Café. 1980-12-13. L.D. Otero; C.L. Ortega leg. E. Amat det 2015 (MIZA); (1 male) Carabobo. Yuma. 1976-02-12. F. Fernández Y, C.J. Rosales leg. E. Amat det 2015. (MIZA); (5 males) Cojedes. La Sierra. Carretera Manrique. 1983-01-28 F. Fernández. Y; J. Clavijo; J. Demarmels leg. E. Amat det 2015. (MIZA); (8 females) Falcón. Cerro Santa Ana. Ladera Moruy. 11°49'21.00"N; 69°56'54.96"O. 300m. 1988-04-16. J.M. González leg. E. Amat det 2015 (MIZA); (1 female) Lara. Carora. 10°10'59.88"N, 70° 4'59.88"O, 1970-08-18. Dilcia Hernández leg. E. Amat det 2015 (MIZA); (3 males) Miranda. Agua Blanca. PN Guatopo. 10° 3'22.19"N; 66°27'52.2"W. 1980-10-08. A. Chacón leg. E. Amat det 2015 (MIZA); (1 female) Same data except Caricuao. 1994-08-29. Pedro Delgado leg. (MIZA); (1 female) Same data except El Hatillo. Las Marías. 10° 25'7.82"N; 66°49'39.2"W. 1350m. 1976-02-20. F. Kaletta leg. (MIZA); (4 females) Same data exceptLos Salias. Altos de Pipe. IVIC. 1600-1700m. 10°24'5"N; 66°58'37"W, Arianna Thomas leg. (IVIC-Neomapas); (1 female) Sucre. Península de París. C.E.U.M. Fac. Agronomía, U.C.V. Maracay. 10.6666 lat, -62.5 lon, E. Amat det 2015 (MIZA); (1 female) Yaracuay. Aroa. 1975-03-12; 1975-03-13 10.25 lat, -68.9166 lon, E. Amat det 2015 (MIZA).

***Chrysomya putoria* (Wiedemann, 1830)**

(Figures 2, 6)

This is another of the exotic species that was introduced decades ago and then widely spread in South America, occuring in Argentina, Bolivia, Colombia, Paraguay, Peru and Uruguay (Baumgartner & Greenberg, 1984). In Peru it was abundant, collected at low lands specially in the rain forest up to 100m (Baumgartner & Greenberg, 1985), although in central Colombia was recorded at intermediate elevation (Ramírez-Mora *et al.*, 2012); recently it was recorded at Merida Cordillera in Venezuela (Velásquez *et al.*, 2017), not reported in mainland Ecuador and northern of Peru. In the Northwest South America it occurs in the Amazonian and the Andean natural region (Figure 6) mainly distributed at low lands (Figure 2). Based on the data retrieved it seems to be synanthropic and it was highly related to urban environments. In Peru it was synanthropic (SI= +98) (Baumgartner & Greenberg, 1985) as in some others regions of Brazil (Ferrerira, 1983). The morphology is detailed in Rognes & Paterson (2005). The identification of the neotropical specimens may be consulted in the key recently proposed by Grella *et al.* (2015). The immatures stages were described by (Greenberg & Szyska, 1984).

Specimens examined. (369 males, 519 females) **Brasil** (74 males, 108 females) (1 male) Amazonas. 2°42'42.19"S; 60°57'17.66"W. 34m. 2013-12-07; 2013-12-08. Navt.3. V[an] S[omeren] R[ydon] mod[ificada]. Leg. E. Amat & M. Marinho Det. E. Amat & A. Pérez 2015 (INPA); (1 female) Same data except 2°37'11.40"S; 60°56'54.55"W. 22m. Navt 6 (INPA); (9 females) Same data except 2°38'28.33"S; 60°56'21.68"W. 77m 2013-12-03. Navt 05. (INPA); (53 males, 44 females) Same data except 2°38'16.61"S; 60° 9'22.70"W. 97m. ZF2T4.01 Leg. E. Amat (INPA); (17 males, 12 females) Same data except 2°38'14.06"S; 60° 9'27.06"W. 116m. ZF2T06.01 (INPA); (4 females) Same data except 3°40'29.47"S; 60°19'49.07"W. 2013-12-12;2013-12-13. 30m. CAC T1. Leg. Marinho M & F Filho (INPA); (1 female) Same data except 3°40'43.53"S; 60°19'36.83"W. 45m CAC T3 (INPA); (1 females) Amazonas. Manaus. Campus Universitario Manaus 1988-08-04; 1988-04-11. Shanon iscas fezes. Leg. Marcia Castilho, J. Elias Binda Det. E. Amat & A. Pérez 2016 (INPA); (22 females) Same data except Feira do Productor. 2001-08-27. Leg. Ale-Rocha, R., Soares, E.F (INPA); (6 females) Same data except Reserva. Feira da Compesa. 2001-08-20 (INPA); (1 male) Same data except Conjunto Manoa 1988-07-22. Leg. B.M. J (INPA); (1 male, 1 female) C. Univ CB. 1988-07-22. Armadilha bufe Leg. Parallupi (INPA); (6 females) Same data except Reserva Florestal Adolpho Ducke. 2° 55'51"S; 59°58'29"W. 1999-07-05; 1999-07-07. Shanon-Carniça. Leg. Pes, A.MO. Det. E. Amat & A. Pérez 2016. 313. (INPA); (1 female) Amazonas. Novo Aripuanã. Reserva Soka. 05° 15'53"S; 60° 07'08"W. 1999-05-05, 1999-04-28. Malaise - Mata Leg. Ferreira, R.L Rocha, R.A Vidal, J, & Leite, R.S. Det. E. Amat & A. Pérez 2016 (INPA). **Colombia** (295 male, 411 females) (14 males, 22 females) Amazonas. Leticia. 4°13.024′S; 69°56.468′O. 79m. UR0101. 2013-12-22. V[an] S[omeren] R[ydon] mod[ificada]. Leg. Varela A Det. E. Amat & A. Pérez 2014 (CETdeA); (5 males, 4 females)

Same data except 2013-12-24. UR0102 (CETdeA); (2 males, 6 females) Same data except UR0301 Leg. Pérez J & Varela A. (CETdeA); (3 females) Same data except 4°13.088′S; 69°56.471′O 153m. 2013-12-24. UR0302 (CETdeA); (5 males, 6 females) Same data except 4°12.669′S; 69°56.546′O. 154m. UR0402 (CETdeA); (218 males, 236 females) Same data except 4°12.537′S; 69°56.645′O. 81m. UR0501 Leg. Amat E (CETdeA); (11males, 23 females) Same data except 2013-12-26. UR0502 (CETdeA); (36 males, 98 females) Same data except 4°13.024′S; 69°56.468′O. 79m. 2013-12-27. UR0602 (CETdeA); (1 male) Same data except Carretera los kms. km5. 4°10.096′S; 69°56.563′O 124m. 2013-12-24. BS0102. V[an] S[omeren] R[ydon] mod[ificada]. Leg. Gómez-P L, Amat E, Del Aguila R. Pérez J & A. Varela (CETdeA); (1 male) Vichada. Cumaribo . Comunidad de Sarrapia. 4°29'16.73"N; 67°52'12.74"W 260m. 2007-03-25. Manual Sobre Cabeza de pescado. Leg. F. Forero 111222 Det. E. Amat 2012 (IAvH-E); (1 female) Same data except 111210 (IAvH-E); (1 female) Same data except 111212 (IAvH-E); (1 female) Same data except 111214 (IAvH-E); (1 male) Same data except 111223 (IAvH-E); (1 male) Same data except 111215 (IAvH-E); (1 female) Same data except 111211 (IAvH-E); (1 female) Same data except 111216 (IAvH-E); (1 female) Same data except 111219 (IAvH-E); (1 female) Same data except 111217 (IAvH-E); (1 female) Same data except 111213 (IAvH-E); (1 female) Same data except 111221 (IAvH-E); (1 female) Same data except 111218 (IAvH-E); (1 female) Same data except 111220 (IAvH-E); (1 female) Same data except 111208 (IAvH-E); (1 female) Same data except 111209 (IAvH-E).

Cochliomyia **Townsend, 1915**

Cochliomyia hominivorax **(Coquerel, 1858)**

(Figures 2, 7)

Commonly known as the New World screw-worm, this is a myiasis producing fly; this species is an obligatory parasite of vertebrates, mainly mammals, cattle, wildlife, pets and humans, it is of veterinary and economic importance due to due to the harmful effects caused to livestock. Before the fifties become the major difficult to the production of livestock in the United States, hence the United States Department of Agriculture (USDA) established a successful control and eradication program based in the sterile insect technique. It has been eradicated from North America down to the region south of Panama (Wyss & Galvin, 1996). Originally it was widely spread from Southern of United States to South America (Dear, 1985). Specimens of flies deposited from entomological collections were not as common as others carrion feeding flies. In the Northwest South America is widely distributed, we reported isolated records from all natural regions except the Orinoquia ante Tepuyan where certainly it occurs (Figure 7). The records are ranging near to the sea level to 1930 m (Figure 2) in the Andes. Further information about biology, ecology, bionomics, control and eradication may be consulted in the annotated bibliography of Snow *et al.* (1981). The morphological identification of adults and the third stage larvae may be consulted in Guimarães & Papavero (1999).

Specimens examined. (3 males, 9 females) **Colombia** (1 male, 3 females); (1 male) Antioquia. Caldas. La clara. 06°03'06.9"N; 75°37'19.2"W. 1.840m. 2010-02-09. 2C2. T[rampa] V[an] S[omeren] R[ydon]. 72 h[oras]. Leg. Manuel Alejandro, Yesica Durango & Hernan Areiza. TdeA-984 Det. A. Ramírez 2010 (CETdeA); (1 female) Antioquia. Medellín. Pajarito. 06°17'10.7"N; 75°36'43.7"W. 1.929m. 2P1. 2010-02-07. T[rampa] V[an] S[omeren] R[ydon]. 72 h[oras]. Leg. Alejandro Ramírez. TdeA-838 Det. A. Ramírez 2010 (CETdeA); (1 female) Same data, except. 2010-02-09. 12P2. Leg. Isabel Cadavid, Ana Varela & Carlos Rave. TdeA 3029 (CETdeA); (1 female) Magdalena. Sevilla. Corpoica Caribia. 10°43'46.54"N; 74°12'51.89"W. 20m. Leg. Salever.D. 270. Det. E. Amat 2015 (CBUMAG). **Ecuador** (1 male, 2 females)**;** (1 female) Orellana. Est.Cient. Yasuni. 0°40'27.08"S; 76°23'48.98"W. 250m. 2009-04-12. Leg. D. Escobar Det. E. Amat 2015 (QCAZ-I); (1 male) Manabí. Rio Manta. 157m. 2012-09-06. Trapa. T2. Malaise 100m. Leg. Ghia & Narvaez E. Amat 2015 (QCAZ-I); (1 female) Napo. Vía muyuna (Casa Sara). 4º38´31.71´´; 74º04´54.02´´. 690m. 2016-07-14. Leg. E. Amat & A. Pérez. TdeA10071. Det. E. Amat 2016 (CETdeA). **Venezuela** (1 male, 4 females) Aragua. Maracay. 450m. 1987-06-23. Dip 03-19. Leg. Elena de Román. Det E. Amat 2011 (MIZA).

***Cochliomyia macellaria* (Fabricius, 1775)**

(Figures 2, 7)

Commonly named the secondary screwworm, because it causes facultative myiasis when the larvae feed on dead tissue in live animals. It is a carrion breeding species of medical, veterinary and forensic importance. This is an endemic species of the new world, widely distributed from Southern North America in Canada to Argentina and Chile (Dear, 1985). (Baumgartner & Greenberg, 1985) mentioned that *C. macellaria* was presumably the most common blow fly in many neotropical areas before arrived of the exotic *Chrysomya* spp., they recorded this species as premontane below 2450m in the central Andes of Peru (Baumgartner & Greenberg, 1985), as it was in Colombia, where is widely spread along all natural regions (Amat, 2009). besides it was closely related to the tropical dry forest and urban environments at low lands in the surroundings of the Sierra Nevada de Santa Marta (Amat, Perez-Hoyos, & Rafael In press). Recently cited in northern Venezuela below 1100 m of elevation (Velásquez *et al.*, 2017). In the Andes of Peru and Colombia it was eusynanthropic as in the Sierra Nevada de Santa Marta (SI=+94. +78, +69 respectively) (Amat, Perez-Hoyos, & Rafae In press.; Baumgartner & Greenberg, 1985; Montoya-G *et al.*, 2009). In the Northwest South America is widely distributed, it occurs in all natural regions (Figure 7). Ranging from the sea level to 1850m (Figure 2). The morphological identification of adults may be consulted in (Dear, 1985; Guimarães & Papavero, 1999), recently the life cycle was studied by (Alvarez Garcia, Pérez-Hérazo, & Amat, 2017) and the immatures stages were studied and documented by (Florez & Wolff, 2009; Greenberg & Szyska, 1984).

Specimens examined. (188 males, 413 females) **Brazil** (16 males, 44 females). (1 male) Amazonas. Manaus. Reserva Florestal Adolpho Ducke. 2°56'1.27"S; 59°58'25.0"W 2938. Det E. Amat & A. Pérez 2016 (INPA); (1 female) Same data except 1963-25-05. Leg. V. Cambibel. 2940. Det. E. Amat & A. Pérez 2017 (INPA); (1 female) Amazonas. Manaus. Est[rada]. Am 10 Km 161969-07-17. Leg. E. V. Silva 2903. Det. E. Amat & A. Pérez 2017 (INPA); (1 female) Same data except INPA Campus 3°5'47"S; 59°59'22"W II Leg. Mario Dantas. Det. E. Amat & A. Pérez 2016 (INPA); (1 female) Same data except Est[rada]. Aleixo Km 3. 1976-06-13Dead Dog. Leg. A. B Anderson Det. E. Amat & A. Pérez 2017 (INPA); (2 males, 2 females) Same data except Campus Univ. Do Amazonas. 03°04"S

;59°57"W 1999-11-05. Isca cachorro em putrefaçao. Leg. Alburqueque Jr., D.P. (INPA); (2 males, 6 females) Same data except Mercado Municipal. 3° 7'28.44"S; 59°59'40.89"W. 2001-08-30. Leg. Ale-Rocha, R., Soares, E.F. Det. E. Amat 2015 (INPA); (4 males, 7 females) Same data except 2001-08-20. Det. E. Amat & A. Pérez 2017 (INPA); (3 males, 20 females) Same data except 2001-08-27. (INPA); (4 females) Same data except 2001-08-17. (INPA); (4 males, 1 female) Amazonas. Tefé. Campus Instituto Mamirauá. 105m. 2016-10. In dead Dolphin Leg. D. Méndez. Det. E. Amat & A. Pérez 2017 (INPA);. **Colombia.** (158 males, 320 females) (1 female) Amazonas. Carretera los kms, km5. 4°10.095′S; 69°56.621′O. 110m. 2013-11-22. BS0401. T[rampa] V[an] S[omeren] R[ydon]. 72 h[oras]. Leg. Del Aguila R, Pérez J & Varela A Det. E. Amat & A. Pérez 2014 (CETdeA); (1 female) Same data except Carretera los kms, km7. 123m. 4°08.325′S; 69°56.396′O. CL0101 (CETdeA); (1 male, 1 female) Amazonas. Leticia. 4°13.024′S; 69°56.468′O. 79m. 2013-11-24. UR0102. Leg. Varela A Det. E. Amat & A. Pérez 2014 (CETdeA); (2 females) Same data except 4°12.669′S; 69°56.546′O. 154m. UR0402. Leg. Pérez J & Varela A (CETdeA); (7 males, 6 females) Same data except 4°12.537′S; 69°56.645′O. 81m. UR0501 Leg. Amat E (CETdeA); (3 females) Same data except 2013-11-26. UR0502 (CETdeA); (19 males, 22 females) Same data except 4°13.024′S;69°56.468′O. 79m. 2013-11-27. UR0602 (CETdeA); (3 females) Boyacá. Moniquirá. Vereda Coralina. 5°52'28.96"N; 73°34'54.18"W. 1720m. Leg. E. Pinzón (UPTC); (11 females) Same data except 1721m (UPTC); (10 females) Same data except 1722m (UPTC); (8 females) Same data except Colecta directa. 1723m (UPTC); (1 female) Casanare. Tamara. San Pedro. 5°45'26.35"N; 72°12'45.00"W. 560m. 2016-05-17. PMT-BdG-VSRDip01. T[rampa] V[an] S[omeren] R[ydon]. 48 h[oras]. Leg. L. E. Franco & F. Velandia. Det. A. Pérez y E. Amat 2016. IAvH-ACF450 (IAvH-E); (1 male, 2 females) Same data except 5°45'10.13"N; 72°12'38.53"W. 570m. PMT-Ptz-VSRDip01. IAvH-ACF462 (IAvH-E); (1 male, 2 females) Same data except PMT-Ptz-VSRDip02. IAvH-ACF466 (IAvH-E); (21 males, 30 females) Same data except PMT-Ptz-VSRDip03. IAvH-ACF469 (IAvH-E); (1 male) Casanare. Poré. La plata. 5°34'13.50"N; 71°54'40.85"W. 204m. 2016-05-20. SBA-B-VSRDip01. Leg. L.E. Franco & D.M. Pinto. Det. A. Pérez y E. Amat 2016. IAvH-ACF472 (IAvH-E); (2 males) Same data except SBA-B- VSRDip02. IAvH-ACF475 (IAvH-E); (3 males) Same data except SBA-B- VSRDip03. IAvH-ACF480 (IAvH-E); (2 female) Same data except 5°34'43.97"N; 71°54'26.01"W. 199m. IAvH-ACF483 (IAvH-E); (1 male) Same data except SBA-Hbz-VSRDip02. IAvH-ACF486 (IAvH-E); (8 males, 12 females) Same data except SBA-Hbz-VSRDip03. IAvH-ACF489 (IAvH-E); (2 males, 3 females) Same data except 5°34'13.89"N; 71°54'7.79"W 200m. SBA-Ptz-VSRDip01. IAvH-ACF493 (IAvH-E); (2 males, 3 females) Same data except SBA-Ptz-VSRDip02. IAvH-ACF496 (IAvH-E); (1 male, 1 female) Same data except SBA-Ptz-VSRDip03. IAvH-ACF500 (IAvH-E); (2 females) Chocó. Bahia Solano. 06°16'0.7"; 77°27'16.3". 50m. 2013-09-25. BSPLT01. Leg. Pérez J, Gómez LM & Quiroz M. Det E. Amat & A. Pérez 2014 (CETdeA); (2 males) Same data except 06°15' 57.9"; 77° 27' 16". 52m. BSPLT02 (CETdeA); (1 male, 2 females) Same data except 06°15'56.6"; 77°27' 17.9". BSPLT03 (CETdeA); (1 female) Same data except 06°15'55.0"; 77°27'26.4". 63m. BSPLT04 (CETdeA); (2 males, 3 females) Same data except 06°16' 13"; 77°27' 25.9". 53m. BSUT13 (CETdeA); (6 males, 3 females) Same data except 06°16'13.2"; 77°27' 27.5". BSUT14 (CETdeA); (1 male, 4 female) Same data except 06°16' 18.3"; 77°27' 33.6". BSUT15 (CETdeA); (1 male, 6 female) Same data except 06° 16' 25.2"; 77°27". 36.1". 56m. BSUT16 (CETdeA); (1 female) Magdalena. Minca. 11° 9'22.30"N; 74° 8'7.80"W. 465m. 2013-03-02. SMT 07. T[rampa] V[an] S[omeren] R[ydon]. 72 h[oras]. Leg. Amat, E. Utria, G y Pérez L. Det. E. Amat & A. Pérez 2013 (CETdeA); (8 males, 19 females) Magdalena. Las Tinajas. 11°15'30.50"N; 74°;4'32.80"W. 388m. 2013-03-03. SMT 09. Leg. Amat, E. Utria, G y Pérez L. Det. E. Amat & A. Pérez 2013 (CETdeA); (1 males, 3 females) Same data except 11°15'14.60"N; 74° 4'25.80"W. 390m. SMT 10 (CETdeA); (1 female) Same data except 11°14'54.50"N; 74° 4'3.00"W 337m. SMT 11 (CETdeA); (5males, 11 females) Magdalena. Vira Vira. 11°14'9.80"N; 74° 4'17.00"W. 259m. 2013-03-03. SMT 12. T[rampa] V[an] S[omeren] R[ydon]. 72 h[oras]. Leg. Amat, E. Utria, G y Pérez L. Det. E. Amat & A. Pérez 2013 (CETdeA); (5 males, 7 females) Magdalena. Palangana. 11°16'23.10"N;74° 9'30.80"W. 195m. 2013-03-03. SMT 13. T[rampa] V[an] S[omeren] R[ydon]. 72 h[oras]. Leg. Amat, E. Utria, G y Pérez L Det. E. Amat & A. Pérez 2013 (CETdeA); (2 females) Same data except 11°16'14.40"N; 74° 9'24.30"W. 153m. SMT 14. (CETdeA); (1 male, 7 females) Same data except 11°15'55.00"N; 74° 9'23.90"W. 180m. SMT 15. (CETdeA); (2 males, 5 females) Same data except 11°15'35.00"N; 74° 9'33.40"W. 145m. SMT 16. (CETdeA); (1 female) Magdalena. Santa Marta. Universidad del Magdalena. 11°13'19.74"S; 74°11'12.29"O. 20m. 2013-11-23. 5947 (CBUMAG); (1 female) Same data except 5944 (CBUMAG); (1 female) Same data except 5945 (CBUMAG); (1 female) Same data except 5948 (CBUMAG); (1 female) Same data except 5941 (CBUMAG); (1 female) Same data except 5946 (CBUMAG); (1 female) Same data except 5942 (CBUMAG); (1 female) Same data except 5940 (CBUMAG); (1 female) Same data except 5943 (CBUMAG); (1 male, 2 females) Same data except SMT 17. 2013-03-04. WOT. 72 h[oras]. Leg Amat, E. Utria, G y Sepúlveda P. Det. E. Amat & A. Pérez 2013 (CETdeA); (7 males, 10 females) Same data except 2016-03-23. T02. Leg. Palmera & Miranda (CETdeA); (3 males, 1 female) Magdalena. Santa Marta. Finca Libano 2000. 11°12'42.83"N; 74°10'12.99"O. 2016-03-23. T01.T[rampa] V[an] S[omeren] R[ydon]. 72 h[oras]. Leg Palmera & Miranda. Det A. Pérez 2016 (CETdeA); (1 female) Magdalena. Tayrona. Gairaca. 11°18'58.68"N; 74° 6'30.15"W 1976-10-18. Leg. C Kugler. Det. E. Amat 2009. 111112 (IAvH-E); (1 female) Magdalena. Santa marta. Finca kalashe-kalabia. 11°16'29.88"N;74° 5'49.74"O2 008-02-02. 143m. Cerdo sol Leg. E. Perdomo & C. Valverde. 2082 (CBUMAG); (1 female) Same data except 7627 (CBUMAG); (1 female) Same data except 2008-01-24. 5994 (CBUMAG); (1 female) Same data except 5992 (CBUMAG); (1 female) Same data except 5991 (CBUMAG); (1 female) Same data except 5995 (CBUMAG); (1 female) Same data except 5987 (CBUMAG); (1 female) Same data except 5986 (CBUMAG); (1 female) Same data except 5989 (CBUMAG); (1 female) Same data except 5090 (CBUMAG); (1 female) Same data except 5993 (CBUMAG); (1 female) Same data except 5920 (CBUMAG); (1 female) Same data except 5916 (CBUMAG); (1 female) Same data except 5949 (CBUMAG); (1 female) Same data except 5922 (CBUMAG); (1 female) Same data except 5921 (CBUMAG); (1 female) Same data except 1997 (CBUMAG); (1 female) Same data except 1943 (CBUMAG); (1 female) Same data except 7638 (CBUMAG); (1 female) Same data except 7639 (CBUMAG); (1 female) Same data except 7640 (CBUMAG); (1 female) Same data except 6194 (CBUMAG); (1 female) Same data except 6196 (CBUMAG); (1female) Same data except 6193 (CBUMAG); (1 female) Same data except 6195(CBUMAG);(1 female) Same data except 6192 (CBUMAG); (1 female) Same data except 7641(CBUMAG); (1 female) Same data except 7642 (CBUMAG); (1 female) Same data except 7643 (CBUMAG); (1 female) Same data except 2019 (CBUMAG); (1 female) Same data except 7621 (CBUMAG); (1 female) Same data except 7618 (CBUMAG); (1 female) Same data except 7617 (CBUMAG); (1 female) Same data except 7616 (CBUMAG); (1 female) Same data except 7614 (CBUMAG); (1 female) Same data except 7613 (CBUMAG); (1 female) Same data except 7612

(CBUMAG); (1 female) Same data except 7619 (CBUMAG); (1 female) Same data except 5918 (CBUMAG); (1 female) Same data except 5955 (CBUMAG); (1 female) Same data except 5959 (CBUMAG); (1 female) Same data except 5956 (CBUMAG); (1 female) Same data except 5954 (CBUMAG); (1 female) Same data except 5957 (CBUMAG); (1 female) Same data except 5961 (CBUMAG); (1 female) Same data except 7610 (CBUMAG); (1 female) Same data except 5925 (CBUMAG); (1 female) Same data except 5917 (CBUMAG); (1 female) Same data except 5923 (CBUMAG); (1 female) Same data except 5919 (CBUMAG); (1 female) Same data except 5924 (CBUMAG); (1 female) Same data except 7611 (CBUMAG); (1 female) Same data except 7620 (CBUMAG); (1 female) Same data except 7615 (CBUMAG); (1 female) Same data except 2008-02-31. 5908 (CBUMAG); (1 female) Santa Marta. Vira Vira. 11°14'9.80"N-74° 4'17.00"W. 259m. 2013-03-03. Leg. L Pérez. Det. A. Pérez & E. Amat 2013. 4858 (CBUMAG); (1 female) Same data except 4857 (CBUMAG); (1 females) Meta. San Martín. La Novilla. 03° 31’ 37.3’’ N; 73° 24’ 16.0’’O. 249m. 2013-06-06. LNBT03 T[rampa] V[an] S[omeren] R[ydon]. 72 h[oras]. Leg. Pérez J y Gómez-Piñerez LM. Det E. Amat & A. Pérez 2013 (CETdeA); (1 female) Same data except 03° 31’ 59.8’’; 73° 23’ 59.0’’. LNPT05. (CETdeA); (15 males, 6 females) Same data except 03° 32’ 08.9’’; 73° 23’ 53.1’’. 262m. LNPT07 (CETdeA); (2 males) Same data except 03° 32’ 11.2’’; 73° 23’ 59.7’’. LNPT08 (CETdeA); (5 males, 6 females) Same data except 03° 32’ 05.4’’; 73° 23’ 33.2’’. 256m. LNST09 (CETdeA); (7 males, 9 females) Same data except 03° 32’ 05.9’’; 73° 23’ 30.6’’. LNST10 (CETdeA); (1 male, 1 female) Same data except 03° 32’ 09.1’’; 73° 23’ 27.6’’. LNST11 (CETdeA); (4 males, 6 females) Same data except 03° 32’ 11.3’’; 73° 23’ 28.3’’. LNST12 (CETdeA); (2 females) Same data except 03° 32’ 00.2’’; 73° 23’ 21.0’’. 244m. LNMT13 (CETdeA); (5 males,7 females) Same data except 03° 31’ 58.2’’; 73° 23’ 20.6’’. LNMT15 (CETdeA); (1 female) Meta. San Martín. Finca El Caduceo. 3º41’40’’N; 73º41’37’’O. 450m. 2005-12-19. Manual/Sobre cabeza de Pescado. Leg. Eduardo Amat García. 111377. Det. E. Amat 2009 (IAvH-E); (1 female) Same data except 111391 (IAvH-E); (1 female) Same data except 111387 (IAvH-E); (1 male) Same data except 111390 (IAvH-E); (1 male) Same data except 111383 (IAvH-E); (1 female) Same data except 111388 (IAvH-E); (1 female) Same data except 111389 (IAvH-E); (1 female) Meta. Puerto. López. Pachiaquiaro. Finca el Saman. 4° 2'44.60"N; 73° 9'12.39"W. 2006-11-03. Leg. Eduardo Amat García & Zenaida Reyes. Det. E. Amat 2009. 111384 (IAvH-E); (1 female)

Same data except 111386 (IAvH-E); (1 female) Same data except 111385 (IAvH-E); (1 male) Same data except 111116 (IAvH-E); (1 female) Vichada. Cumaribo. Corregimiento Santa Rita. 4°35'33.00"N; 69°47'24.98"O. 2004-02-18. Trampa excremento humano. Leg. Ingrid Quintero & Elvia González. Det. E. Amat. 80651 (IAvH-E); (1 female) Vichada. Cumaribo. Selva de Mataven. 4°21'20.00"N; 69°47'38.66"O 2007-03-25. Jama Sobre cabeza de Pescado. Leg. Fernando Forero. Det. E. Amat. 111124 (IAvH-E). **Ecuador.** (2 males, 3 females) (2 females) Napo. Tena. 0°59'56.74"S; 77°50'11.89"O. 561m. 2015-10-30. Leg. M. Domínguez. Det. E. Amat 2016. P4T1 (QCAZ-I); (1 female) Same data except P4T2 (QCAZ-I); (1 male) Napo. Sarayacu. 0°41'43.18"S; 77°48'1.37"W. 1300m. 2015-10-29. Leg. M. Domínguez. Det. M. Domínguez 2015. QCAZ212286 (QCAZ-I); (1 male) Santo Domingo. Otongachi. 0°23'37.87"S; 78°57'43.01"W. 1600m. 2013-08-11Leg. M. Domínguez. Det E. Amat 2015. QCAZ115005 (QCAZ-I). **Venezuela** (12 males, 36 females) (4 females) Amazonas. Rio Autana. Det. E. Amat 2010 (MIZA); (1 female) Amazonas. Pto. Ayacucho Det. E. Amat 2010 (MIZA); (1 female) Apure. Rio Meta. 6°13'4.45"N; 68°33'39.54"O. Det. E. Amat 2010 (MIZA); (1 female) Same data except El Potrero (MIZA); (1 male) Leg. Elena de Romín. Maracay. 450m. 1987-06-23. Det. A. Thomas (MIZA); (5 males, 20 females) Bolívar. Uruyén 500m. 1956-04-13 5°40'38.07"N; 62°26'59.08"O Det. E. Amat 2010 (MIZA); (3 females) Carabobo. C. Tacarigua. Det. E. Amat 2010 (MIZA); (1 female) Caracas. Jardín Botánico. 10°29'41.57"N; 66°53'38.78"O. 1966-01-19. Leg. Alba Díaz Det. E. Amat 2010 (MIZA); (3 females) Same data except 10° 29'42.91"N; 66°53'37.28"O (MIZA); (1 female) Caracas. El Valle. Det. E. Amat 2010 (MIZA); (5 males) Miranda. El Hatillo. Las Marías. 10° 25'7.82"N; 66°49'39.2"W. 1850m. 1975-10-25. Leg. F. Kaletta Det. E. Amat 2010 (MIZA); (1 male) Monagas. Uverito Det. E. Amat 2010 (MIZA); (1 female) portuguesa. Guanare. Det. E. Amat 2010 (MIZA).

Compsomyiops Townsend, 1918

Compsomyiops alvarengai (Mello, 1968)

(Figures 2, 8)

This species was originally described by Mello (1968) under *Paralucilia*, the holotype was a male from a locality in La Paz, Bolivia (at 3600 m), seems to displays an Andean distribution apparently southward from Ecuador to Chile (Dear, 1985). The morphological identification of adults may follow the taxonomic key of Dear (1985). Nothing is known about its biology, bionomical and synanthropic aspects; their immatures stages also are unknown. In the Northwest South America it is reported at 2200 m elevation in the Andes of Ecuador. (Dear, 1985) (Figure 8, 2) We did not revised any specimen of *C. alvarengai* in this study.

Compsomyiops boliviana **(Mello, 1968)**

(Figures 2, 8)

This species was originally described by Mello (1968) under the genus *Paralucilia* and then combined as *C. boliviana* by Dear (1985), who also proposed *Paralucilia. arequipensis* Mello 1968 as junior synonym. The validity of the name *C. boliviana* was questioned by González-Mora *et al.* (1998), who combined the name *C. arequipensis* and proposed this name as valid arguing page priority. Here we follow the proposal of Dear (1985) currently validated by the Systema Dipterorum (Pape & Thompson, 2013). This is a high elevation species distributed from Ecuador throughout the Bolivian Andes. In Peru it was common above 3550m elevation and it was associate with pastures (Baumgartner & Greenberg, 1985). In the Northwest South America occurs in the Andean region (Figure 8), it was recorded from intermediate to high elevations of Ecuador (Dear, 1985; González-Mora *et al.*, 1998) (Figure 2). In Peru it was hemisynanthropic (Baumgartner & Greenberg, 1985). The morphological identification of adults may be consulted in Dear (1985). Although the immatures stages are undistinguished from *C. verena*, they were described by Greenberg & Szyska (1984). We did not find and revised any specimen of *C. boliviana*.

Compsomyiops melloi **Dear, 1985**

(Figures 2, 8)

This species was briefly described by Dear (1985) based in a female holotype presumably from Mexico ("*Mexico City - 8100 feet*") and two females paratypes from Bogota, Colombia (Figure 8). The male is unknown. Dear (1985) stated the wide of the frons as a diagnostic character: *"(♀ Only) Head. Frons equal to 0.40 of the head-width*"; and commented it geographical distribution in Mexico and Colombia. We reviewed the Colombian paratypes housed in the Smithsonian Institution (USNM) but the narrower frons ratio of 0.36 together with the disjoint geographical distribution proposed by Dear (1985) makes the real identity of the Colombian specimens doubtful. The Colombian paratypes are similar to the polymorphic *C. verena*, which is the most common *Comspomyiops* species in the Colombian Andes. Thus, *C. melloi* would be geographically restricted to Central America until the holotype be revised. These appraisals together with the lack of male morphology description, question the validity of this species. We did not revised any specimen of *C. melloi*.

Compsomyiops verena **(Walker, 1849)**

(Figures 2, 8)

This is a neotropical montane species distributed from Costa Rica to Peru (Baumgartner & Greenberg, 1985; Dear, 1985). In Peru it was eurythermal, from 1200 to 3000 m elevation. The same elevation pattern was reported in Colombia where is commonly collected (Amat, 2009); while in Venezuela it was recorded at intermediate elevations of the Merida and the Coastal range (Velásquez *et al.*, 2017). lately it was reported as one of the most frequent species in the Páramo environments at central range of Colombia and Ecuador (Amat, Perez-Hoyos & Alvarez *et al* In press). and in the sierra Nevada de Santa Marta ocurring the Páramo and the montane rain forest (Amat, Perez-Hoyos, & Rafael In press). In Peru it was asynanthropic (Greenberg & Szyska, 1984), unlike in Colombia where was hemisynanthropic (Pinilla-Beltran *et al.*, 2012) as it was in the páramo environment (Amat, Perez-Hoyos, Alvarez In press). Due to its colonizer habits of carrion it is of forensic and medical importance, the life cycle was studied by (Segura *et al.*, 2005). In the North West South America, it occurs mainly in the Andean region with some records in the Caribbean region at the coast cordillera in Venezuela (Figure 8). It was apparently eurythermal, collected from

1417m at temperate localities to 3376 m of the Páramo (Figure 2). The morphological identification of adults and the nomenclatural history is detailed in (Dear, 1985). the immatures stages were studied by Florez & Wolff (2009); Greenberg & Szyska (1984).

Specimens examined. (166 males, 429 females) **Colombia** (37 males, 145 females) (2 males, 2 females) Antioquia. Belmira. Montañitas. 6°36'5.05"N; 75°43'22.75"W. 2012-02-13. Tramp[a] Copro. T[rampa] V[an] S[omeren] R[ydon]. 72 h[oras]. Leg. F. Álvarez Det. A. Pérez 2012 (CETdeA); (2 males, 30 females) Same data except El Morro. 6° 38' 27,43" N; 75° 40' 19,84" W. 3127m. T[rampa]01 (CETdeA); (1 female) Same data except El indio. 6° 36' 42,64" N; 75° 42' 41,63" W. 2830m. 2012-03-05. T[rampa]01 (CETdeA); (1 female) Antioquia. Caldas. 6.090000; -75.637500. Leg. Gallego. E. Amat 2009 (MEFLG); (1 female) Same data except Caldas. La Clara. 06º03'06.9"N; 75º37'19.2"W. 1840m. 2010-10-06. 10C1. Tramp[a] Copro. T[rampa] V[an] S[omeren] R[ydon]. 72 h[oras]. Leg. M.A. Ramírez, I. Cadavid, C. Rave. Det. A. Pérez 2012 (CETdeA); (1 female) Antioquia Medellín. 6.250000; -75.583300Leg. E. Madrigal. Det. E. Amat 2009 (MEFLG); (1 female) Same data except Cola del Zorro. 06º12'19.7"N; 75º32'43.9"W. 1943m. 2010-10-08. 10CZ2. Tramp[a] Copro. T[rampa] V[an] S[omeren] R[ydon]. 72 h[oras]. Leg. M.A. Ramírez, I. Cadavid, C. Rave. Det. A. Pérez 2012 (CETdeA); (4 males, 12 females) Same data except Pajarito. 06º17'10.7"N; 75º36'43.7"W. 1929m. 2010-10-08. 10P2. Leg. M.A. Ramírez, I. Cadavid, C. Rave. Det. A. Pérez 2012 (CETdeA); (6 males, 15 females) Antioquia. Medellín. Copacabana. 06º22'07.1"N; 75º29'22.3"W. 1417m. 2010-11-10. 11CP1. Leg. M.A. Ramírez, I. Cadavid, C. Rave Det. A. Pérez 2012 (CETdeA); (1 female) Antioquia. La Ceja. 6.032700; -75.443000. Leg. Gallego. Det. E. Amat 2009 (MEFLG); (1 female) Antioquia. Rio negro. 6.155000; -75.373600. Leg. Gallego. Det. E. Amat 2009 (MEFLG); (1 female) Antioquia. Guarne. 6.283300; -75.433300. Leg. E. Madrigal. Det. E. Amat 2009 (MEFLG); (1 female) Antioquia. Puerto Triunfo. Reserva Ecológica. El Cañón del Rio claro. 800m. Leg. A. Alba. Det. E. Amat 2009 (UNAB); (1 female) Boyacá. Iguaque. Cabaña Chaina. 5.694050; -73.450000. 2600m. Leg. P. Reina Det. E. Amat 2009 (IAvH-E); (1 male) Boyacá. Villa de Leyva. Cabaña Mamarramos. 5°42'10.34"N; 73°27'19.29"W. 2855m. 2000-05-06. Malaise. Leg. P. Reina. Det. E. Amat 2009. 111234 (IAvH-E); (1 male) Same data except 2000-09-26. 111232 (IAvH-E); (1 male) Same data except La Planada. 2850m. 2000-10-11. 111233 (IAvH-E); (1 male) Same data except 111230 (IAvH-E); (1 female) Same data except Cabaña Chaina. 2600m. 2001-05-17. 111228 (IAvH-E); (1 female) Same data except 111224 (IAvH-E); (1 female) Same data except 111225 (IAvH-E); (1 male) Same data except 111236 (IAvH-E); (1 male) Same data except 111235 (IAvH-E); (1 female) Same data except 2001-08-31. Malaise. Leg. Roberto A. 111227 (IAvH-E); (1 female) Same data except 111226 Leg. Roberto A (IAvH-E); (1 female) Same data except 111231 (IAvH-E); (1 female) Boyacá. Páez. Leg. E. Cruz. Det. E. Amat 2009 (ICN-MHN); (1 female) Boyacá. Sogamoso. 5.716600; -72.933300Leg. G. Ardila. Det E. Amat 2009 (UNAB); (2 males, 5 females) Cundinamarca. Bogotá. Universidad Nacional. 4º38´31.71´´; 74º04´54.02´´2560m. 2014-03-30. UNBOG0201. T[rampa] V[an] S[omeren] R[ydon]. 72 h[oras]. Leg. J García. & E Ariza. Det. A. Pérez & E. Amat 2014 (CETdeA); (5 females) Same data except 2014-04-01. UNBOG0202 (CETdeA); (1 male, 4 females) Same data except 2014-05-9,12. UNBOG0301 (CETdeA); (3 males, 10 females) Same data except 2014-05-19,22. UNBOG0302 (CETdeA); (1 male) Same data except 2014-06-13,16. UNBOG0401 (CETdeA); (1 male, 2 females). Same data except 2014-06-24. UNBOG0402 (CETdeA); (5 males, 10 females) Same data except 2014-07-25,28. UNBOG0501 (CETdeA); (3 males, 8 females) Same data except 2014-08-1,4. UNBOG0502 (CETdeA); (1 female) Cundinamarca. Bogotá. Alto del cable. 3100m. Det. E. Amat 2009. MLMJ (ICN-MHN); (1 female) Same data except Leg. J. Idrobo Det. E. Amat 2009(ICN-MHN);(1 female) Cundinamarca. Bogotá. 2500m. Leg. S. Zuluaga. Det. E. Amat 2009 (ICN-MHN); (1 female) Cundinamarca. Bogotá. Barrio Normandia. 2550m. Det. E. Amat 2009. MLMJ (ICN-MHN); (1 female) Cundinamarca. Bogotá. Monserrate. 4°35'60.00"N; 74° 3'16.70"W. 2830m. Leg. H. Rojas Adulto. Det. E. Amat 2009 (ICN-MHN); (1 female) Cundinamarca. Bogotá. Suba "Lomas José". 4°46'5.48"N; 74° 4'14.61"W. 2630m.Leg. J. Perea. Det. E. Amat 2009 (ICN-MHN); (1 female) Cundinamarca. Cáqueza. 4.416600; -73.950000. Leg. J. Arias. Det. E. Amat 2009 (UNAB); (1 female) Cundinamarca. Facatativa. Carretera San Francisco. 2400m. Leg. R. Viloria Det. E. Amat 2009 (ICN-MHN); (1 female) Cundinamarca. La Calera 4.716600; -73.966600. 2800m. MLMJ Det. E. Amat 2009 (ICN-MHN);(1 female) Cundinamarca. Mosquera. Corpoica-Tibaitatá. 4º42'0"N; 72º12'0"W. 2543m. Leg. G. Camacho &F. Ospina. Det. E. Amat 2009 (ICN-MHN); (1 female) Cundinamarca. Pacho. 5.133300; -74.166600. Leg. G. Corredor. Det. E. Amat 2009 (UNAB); (1 female) Cundinamarca. Simijacá. Leg. Fique & Reina Det. E.

Amat 2009 (UNAB); (1 female) Cundinamarca. Soacha. 4º35'0"N; 74º15'0"W. Leg. R. Artunduaga. Det. E. Amat 2009 (UNAB); (1 female) Cundinamarca. Ubaté. Leg. A. Torres. Det. E. Amat 2009 (UNAB); (1 female) Cundinamarca. Zipacón Leg. A. Mora. Det. E. Amat 2009 (UNAB); (1 female) Cundinamarca. Zipaquira. Planta de Tibitó. Leg. A. Méndez. Det. E. Amat 2009 (ICN-MHN); (1 female) Same data except Leg. J. Rojas (ICN-MHN); (1 male) Magdalena. Santa Marta. Sierra Nevada. El Ramo. 10º48'0"N; 73º39'0"W. 2000m. 2000-12-29. Malaise. Leg. J. Cantillo. Det. E. Amat 2009. 111229 (IAvH-E); (1 female) Quindio. Salento. La Montaña. CRQ. Leg. C. Muñoz. Det. E. Amat 2009 (ICN-MHN); (1 female) Tolima. Ibagué. 4.437200; -75.225800. Leg. O. Jiménez Det. E. Amat 2009 (ICN-MHN); (1 female) Ubaque. Vda San Antonio. 2100m. Leg. C. Bejarano. J. Díaz & E. Guzmán Det. E. Amat 2009 (UNAB); (1 female) Tolima. Herveo. 5º5'0"N; 75º10'0"W. Leg. H. Quintero Det. E. Amat 2009 (UNAB); (1 female) Norte de Santander. Cucuta. 7.900000; -72.516600. Leg. R. Lewis. Det. E. Amat 2009 (UNAB). (1 female) Bogota. B Guevara. Paratype female of *Compsomyiops melloi* Dear (USNM); (1 female) Bogota. May 21, 1942 W.H.W. Komp., Paratype female of *Compsomyiops melloi* Dear (USNM). **Ecuador** (128 males, 276 females.) (12 males, 20 females) Napo. Papallacta. 0°22'23.24"S; 78° 8'22.35"W. 3376m. 2015-10-31. P1T4. T[rampa] V[an] S[omeren] R[ydon]. Leg. M. Domínguez. Det. M. Domínguez 2014 (QCAZ-I); (6 males, 18 females) Same data except 2015-11-01. P1T2 (QCAZ-I); (11 males, 22 females) Napo. Baeza. 0°28'2.31"S; 77°53'33.65"W. 1948m. 2015-10-31. P2T4. Leg. M. Domínguez. Det. M. Domínguez 2014 (QCAZ-I); (6 males, 10 females) Same data except 2015-11-01. P2T2 (QCAZ-I); (68 males, 112 females) Pichincha. Quito. Bosque metropolitano del sur. 0°20'34.84"S; 78°31'8.77"W. 3060m. 2016-08-23. BMS-BT05. T[rampa] V[an] S[omeren] R[ydon]. 48 h[oras]. Leg. A. Torres Det. A. Torres 2016 (QCAZ-I); (21 males, 86 females) Pichincha. Cantón Quito. Parroquia de Lloa. Valle Lloa. 0°14´41.24´´S; 78°33´28.94´´O. 3157m. 2016-06-29. LBT03. Leg. A. Torres. Det. A. Torres 2016 (QCAZ-I); (2 males, 1 female) Quito. Pinchicha. Ciudad, flor de chilca. 0.268020; -78.514130. 1985-02-01. Leg. M.A. Calderón. Det. E. Amat 2015 (QCAZ-I); (2 males) Quito. Pichincha. 00º9'0"N; 78º30'0"W. 2800m. 1982-12. Leg. J.J. Espinosa Det. E. Amat 2015 MECN-1 Dip-0864 (MECN); (1 female) Tungurahua. Via baños Puyo Km 15 Casc[ada]. Manto de novia 2002-02-11. Leg. A. A Curio. Det. E. Amat 2015 (QCAZ-I); (1 females) Tungurahua. Llanganates. 3342m. 2015-02-21. Leg. S. Aguirre. Det.

E. Amat 2015. QCAZ I 200700 (QCAZ-I); (1 female) Same data except QCAZ I 200701 (QCAZ-I); (1 female) Same data except QCAZ I 200708 (QCAZ-I); (1 female) Same data except QCAZ I 200705 (QCAZ-I); (1 female) Same data except 2015-02-22. QCAZ I 200765 (QCAZ-I); (1 female) Same data except QCAZ I 200764 (QCAZ-I). **Venezuela** (1 males, 6 females.) (1 female) Aragua. Carret. Maracay, Choroni. 1540m. 1971-04-02. Det. E. Amat 2011 (MIZA); (2 females) Caracas. Serrania. El Avila, Galipan. 1800m. 1950-07-16. Leg. F. Fernández Y. Det. E. Amat 2011 (MIZA); (1 female) Caracas. El Junquito. 2000m. 1978-03-22. Det. E. Amat 2011 (MIZA); (1 male, 1 female) Miranda. El Joque. 2000m. 1978-02. Leg. Bordón. Det. E. Amat 2011 (MIZA); (1 female) Vargas. Gengibrillar. Geremba. 2300m. 1994-09-03. Leg. Luis A. Campos. Det. E. Amat 2011 (MIZA).

Hemilucilia **Brauer, 1895**

Hemilucilia benoisti Séguy, 1925

(Figures 2, 10)

This is a neotropical species of wide distribution in low lands, from Costa Rica to Brazil (Peris & Mariluis, 1989). In Peru it was collected in the lower forest (200m), it was rare and asynanthropic (Baumgartner & Greenberg, 1985). Recently it was reported in the foot hill of the Sierra Nevada de Santa Marta, where it was an uncommon fly, also asynanthropic and related to the premontane moist forest below the 500 m (Amat *et al.* In press.). In the Northwest South America it occurs in the Amazonian and along the eastern slope of the Andes (Figure 10), where reaches an altitude of 700m (Figure 2). The species was redescribed by Dear (1985). The historical nomenclature and the morphological identification of adults may follow the keys of Dear (1985) and Peris & Mariluis (1989). Despite *H. townsendi* appears as a valid species in Pape & Thompson (2013), we considered it as a junior synonym of *H. benoisti* as proposed and argued by Peris & Mariluis (1989). Their immature stages are unknown.

Specimens examined. (4 males, 2 females) **Colombia** (1 male) (1 male) Magdalena. Santa marta. Tigreara. Cuenca del rio Gaira. 11° 9'47.02"N; 74°10'15.78"W Elevación Min 140M-Elevación Max 230m. 2004-06-29. T[rampa]56. Leg. D. Ospino, H García. Det. E. Amat 2014 (IAvH-E). **Ecuador** (2 males, 1 female) (1 male) Napo.Tena. Via Muyuna. 0°55'51.94"S; 77°52'50.51"O. 700m. 2016-07-03. TL246. Leg. E. Amat y A. Pérez. Det. E. Amat 2016. TdeA10064 (CETdeA); (1 male) Same data except TL247. TdeA10065 (CETdeA); (1 female) Same data except TL248. TdeA10066 (CETdeA). **Perú** (1 male, 1 female) **(**1 male) Pasco. Oxapampa. Bosque San Matias y San Carlos. 10°30'43.43"S; 75° 4'20.60"O 586m. 2015-05-03;2015-03-06.TL287. Leg. E. Amat, J. Huanca & M. Palomino. Det. E. Amat 2016. TdeA10100 (CETdeA); (1 female) Same data except TL288. TdeA10101 (CETdeA).

Hemilucilia melusina **Dear, 1985**

(Figures 2, 9)

This is a neotropical Andean species. it occurs in Peru and Colombia (Dear, 1985; Peris & Mariluis, 1989) presumably in Ecuador. In Peru it was an uncommon fly, asynanthropic and restricted to the 1400-1800 m at the eastern slope of the Andes, highly attracted to traps baited with fish (Baumgartner & Greenberg, 1985). In Colombia occurs in the Andean region (Amat 2009); recently it was reported in the northern of the Andes near to Venezuela at 2360m (Wolff & Kosmann, 2016). In the Northwest South America, it was endemic of the Andean region (Figure 9) in the range of 2200 m to 2600m (Figure 2), inhabits well-preserved environments. The morphology is detailed in Dear (1985). the morphological identification of adults may follows the keys of Dear (1985) and Peris & Mariluis (1989). The immature stages are unknown.

Specimens examined. (1 female) **Colombia** (1 female) Risaralda. El molinillo. 4°43'0.00"N; 75°34'0.00"W. 2200m. 2003-02-17. Malaise tramp[a] Leg. G. López. 111150 (IAvH-E).

Hemilucilia segmentaria **(Fabricius, 1805)**

(Figures 2, 10)

This is a neotropical species widespread distributed from Mexico to Argentina (Dear, 1985; Peris & Mariluis, 1989). In Peru it was an uncommon fly species, usually collected in the lower rain forest (200m) where it was asynanthropic (Baumgartner & Greenberg, 1985). common in the Brazilian Amazon region (E. Amat *et al.*, 2016). In Colombia is widely distributed where it reaches 1200m including records of pacific insular localities at Gorgona Island (Amat, 2009). Lately it was reported as a uncommon and asynanthropic fly (S.I=-100) in the Sierra Nevada de Santa Marta, closely related to the premontane moist forest (Amat *et al.* In press). Also recently reported in Venezuela in the Merida cordillera and the Venezuelan coastal range below the 1600m (Velásquez *et al.*, 2017). In the Northwest South America, it occurs in all natural region except in the Tepuyan and Orinoquia. The records include mainly the low lands and the inter-Andean valleys (Figure 10) in the range of 140 to 1740m (Figure 2). Inhabits well-preserved environments. The morphology is detailed in Dear (1985). the morphological identification of adults may follows the keys of Dear (1985) and Peris & Mariluis (1989). The immature stages of Colombian specimens were studied and described by Florez & Wolff (2009).

Specimens examined. (22 males, 92 females) **Brazil** (17 females, 2 females) Amazonas. Barcelos. Serrinha. 50m. 2007-07; 2007-08. arm[adilha] malaise Leg. A. S.Philo, T. Krolow. Det. E. Amat 2016 (INPA); (1 female) Same data except Rio demeni Alubiá. 0° 16'07"S; 62°44'45"W. 47m. 2008-08. Leg. A. Silva, R. Machado (INPA); (1 female) Amazonas. P[ar]q[ue] Nac[ional] Jau. Carabinani. 52m. 1995-05-03; 1995-04-27. arm[adilha] malaise Leg. J. A. Rafael & J. Vidal. Det. E. Amat & A. Pérez 2016 (INPA); (1 female) Amazonas. Manaus. Reserva Florestal Adolpho Ducke. 2°52'52.00"S; 59°57'12.16"W. 1981-12-23. Leg. J.A. Rafael. Det. E. Amat & A. Pérez 2016 (INPA); (1 female) Same data except 1988-11-24 (INPA); (1 female) Same data except 2°55'54.0"S; 59°58'25.0"W. 2014-07-18. T[rampa] V[an] S[omeren] R[ydon]. RADT01. Leg. E Amat & A Pérez (INPA); (1 female) Same data except Campus Uni[versidade] UFAM. 3° 5'47.09"S; 59°58'10.06"W. 1988-08-05. Shannon fezes. Leg. Marcia Castilho, J Elias Binda. Det. E. Amat & A. Pérez 2016 (INPA); (1 female) Same data except 1982-07-19. Leg. J. A. Rafael (INPA); (3 females) Same data except

Estación investigación INPA. 2°38′.14.2"S; 60°09′27.0"O. 2013-12-05. ZF2T06 Leg. E. Amat (INPA); (1 female) Same data except Campus Universitario MAO. 1988-08-05; 1988-07-28 Arm[adilha] Shannon iscas Pezes Leg. Marcia Castilho, J. Elias (INPA); (2 females) Same data except C. Univica. 1988-05-14; 1988-05-17. Leg. E. Binda & M-C. Castilho (INPA); (1 female) Same data except Ilha de Maraca. 1987-02-20; 1987-02-30. arm[adilhia] malaise Leg. Luis S. Aquino. Det E. Amat 2016 (INPA); (1 female) Roraima. Serra Pacaraima. BR-174. 04°27′04"N; 61°07′56"W. 800m. 1995-09-01;1995-09-07. Leg. J. A. Rafael, A.L Henriques & J. Vidal. Det. E. Amat 2016 (INPA). **Colombia** (15 males, 37 females) (1 female) Amazonas. Matamatá. 3°48'49.75"S; 70°15'14.86"W. 2000-03-08. Leg. M. Sharkey. Det. E. Amat 2015. 111144 (IAvH-E); (1 male) Same data except 150m. Leg. M. Sharkey & B. Brown. Det. E. Amat 2011 (IAvH-E); (2 females) Antioquia. Copacabana. Ankon. 06º22'07.1"N; 75º29'22.3"W. 1.417m. 2010-03-10. 3CP1. T[rampa] V[an] S[omeren] R[ydon]. 72h[oras]. Leg. M.A. Ramírez, C. Rave. Det. A. Pérez 2011 (CETdeA); (6 males, 2 females) Antioquia. Caldas. La Clara. 06º03'06.9"N; 75º37'19.2"W. 1.840m. 2010-09-08. 9C1. T[rampa] V[an] S[omeren] R[ydon]. 72h[oras]. Leg. M.A. Ramírez, I. Cadavid, C. Rave. Det. E. Amat 2011. TdeA 1829 (CETdeA); (3 males, 4 females) Antioquia. Medellín. Cola del Zorro. 06º12'19.7"N; 75º32'43.9"W. 1.943m. 2010-08-06. 8CZ2. T[rampa] V[an] S[omeren] R[ydon]. 72h[oras]. Leg. M.A. Ramírez, I. Cadavid, C. Rave Det. E. Amat 2011 (CETdeA); (1 female) Caldas. Cañaveral La Mula. 5.3166; -74.9166. 320m. Leg. E. Martínez. Det. E. Amat 2011 (MEFLG); (1 female) Chocó. Bahia Solano. 6°16'6.96"N; 77°27'15.84"W. 2013-09-25. BSPLT06. Leg. J. Pérez, LM. Gómez & M. Quiroz. Det. A. Pérez 2016 (CETdeA); (3 female) Same data except 06°16' 22.7"; 77°27' 39.6". BSPLT10 (CETdeA); (1 female) Choco, Rio San Pichi. 10m. Leg. B. Brown. Det. E. Amat 2011 (IAvH-E); (1 female) Same data except 06:01 N; 77:20 W. 2000-06-30. 111140. Det. E. Amat 2015 (IAvH-E); (1 female) Cundinamarca. Quipele. Finca El Cajon. 04:39:51 N; 74:36:28 W. Leg. L. Mendoza. Det. E. Amat 2015. 111146 (IAvH-E); (1 female) Same data except 111147 (IAvH-E); (1 female) Same data except 111145 (IAvH-E); (1 female) Cundinamarca. La Mesa. V[ere]da San Javier Leg. J. Pardo. Det. E. Amat 2011 (UNAB); (1 female) Cundinamarca. Villeta. 5.0166; -74.4833. Leg. P. García. Det. E. Amat 2011 (UNAB); (1 male) Magdalena. Gairaca, Abanico Aluvial. 1977-05-05. Leg. C. Kluger. Det. E. Amat 2015. 111141 (IAvH-E); (1 female) Magdalena. Los Naranjos. 11.3000; -73.9000. Leg. C. Kluger. Det. E. Amat

2011 (IAvH-E); (1 female) Magdalena. Santa Marta. Minca. 11° 7'48.67"N; 74° 6'32.48"W. Det. E. Amat 2011 (IAvH-E); (3 females) Same data except 11° 7'57.20"N; 74° 7'7.80"W. 680m. 2013-03-02. SMT 05. T[rampa] V[an] S[omeren] R[ydon]. 72h[oras]. Leg. E. Amat; L Pérez & P. Sepúlveda. Det. E. Amat & A. Pérez 2014 (CETdeA); (4 males) Same data except SMT 06 (CETdeA); (1 female) Magdalena. Santa Marta. C. Tigrera. cuenca del Rio Gaira. sector la Bocatoma. RN La Tigrera. 11:09:04 N; 74:09:13 W. 2004-07-03. Leg. D. Ospino & H García. Det. E. Amat 2015. 111143 (IAvH-E); (1 male, 3 females) Magdalena. Santa Marta. Cincinati. 11° 6'6.80"N; 74° 4'52.30"W 1450m. 2013-03-02. SMT 01. T[rampa] V[an] S[omeren] R[ydon]. Leg. E. Amat; L Pérez & P. Sepúlveda. Det. E. Amat & A. Pérez 2014 (CETdeA); (1 male, 1 female) Same data except SMT 02 (CETdeA); (1 male) Meta. Macarena. 2.1772; -73.7913. Leg. C. Santana. Det. E. Amat 2011 (UNAB); (1 female) Putumayo. Puerto Leguizamo. F[in]ca. Charapa. 330m. Leg. R. Cobete. Det. E. Amat 2011 (IAvH-E); (1 male) Valle del Cauca. Mateguadua. Jardín Botánico José María Céspedes. 1100m. Leg. Cogua & Romero. Det. E. Amat 2011 (MPUJ). **Ecuador** (4 males, 15 females) (1 male) Orellana. S.C. Yasuni. 217m. 2012-07-04. Leg. K. Bustamante. Det. E. Amat 2015 (QCAZ-I); (2 males, 6 females) Orellana. Yuturi. 220m. 1990-01-05. Leg. M. Sandoval. Det. E. Amat 2015 (QCAZ-I); (1 female) Orellana. Coca. 260m. Leg. G. Onore. Det. E. Amat 2015 (QCAZ-I); (2 females) Napo. Baeza. 0°28'2.31"S; 77°53'33.65"O 1948m. 2015-10-31. P2T2. Leg. M. Domínguez. Det. M. Domínguez 2015 (QCAZ-I); (1 female) Napo. Sarayacu. 0°41'43.18"S; 77°48'1.37"O. 1312m. 2015-10-30. P3T1. Leg. M. Domínguez. Det. M. Domínguez 2015 (QCAZ-I); (2 females) Napo. Tena. 0°59'56.74"S; 77°50'11.89"O. 561m. 2015-10-29. P4T3. Leg. M. Domínguez. Det. M. Dominguez 2015 (QCAZ-I); (1 male, 1 female) Same data except P4T1 (QCAZ-I); (2 females) Same data except 2015-10-30 (QCAZ-I). **Venezuela** (3 male, 23 females) (3 females) Amazonas. Río Negro. Río Baria. 0°55'35.47"N; 66°10'29.90"W. 140m. 1984-03-25Leg. C. Padilla (MIZA); (1 male) Aragua. El Limón. 450m. 10.321331; -67.623766. 1977-11-13. Luz de mercurio. Leg. F. Fernández. Y. Det. A. Thomas 2013 (MIZA); (5 females) Same data except 1971-08-16. Leg. C. J. Rosales (MIZA); (1 female) Aragua. La Victoria. Maletero. 1977-10-08 (MIZA); (1 female) Aragua. Pico Guacamaya PN Henri Pittier. 1740m (MIZA);(1 female) Aragua. Rancho Grande; PN Henri Pittier. 1100m (MIZA); (1 female) Same data except Portachuelo (MIZA); (1 male) Bolívar. Salto Pará. Rio caura. 250m. 8.238838; -62.705828. 1978-11-20; 1987-11-

22. Leg. B. Bechyne. Det. A. Thomas 2013 (MIZA); (3 females) Caracas DF. Jardín Botánico. 890m. 1966-04-22. Leg. A. Díaz. Det. A. Díaz (MIZA); (3 females) Miranda. El Hatillo. Las Marías. 10.417211; -66.795582. 1974-02-19. Leg. F. Kaletta (MIZA); (1 female) Miranda. Los Chorros (MIZA); (1 male) Same data except 1982-01-27. Leg. R. Candia. Det. A. Thomas 2013 (MIZA); (1 female) Miranda. Los Salias. Altos de Pipe. IVIC. 10.399154; -66.98595. 71600-1700m (MIZA); (1 female) Falcón. Curimagua. San Lorenzo. 1040m. Leg. F. Cerda. 1993-05-21;1993-05-24. L Joy. V Savini. A. Chacón (MIZA); (1 female) Sucre. Valdez. Via Don Pedro. 10.642976; -62.176522 (MIZA); (1 female) Trujillo. La Gira. Cerca de Botijoque. 500m (MIZA).

***Hemilucilia semidiaphana* (Rondani, 1850)**

(Figures 2, 9)

This is a neotropical species widespread distributed from Mexico to Argentina (Dear, 1985). In Peru it was asynanthropic (S.I=-73); a common fly usually collected from 200 to 1450m in well preserved enviroments (Baumgartner & Greenberg, 1985). In Colombia it was commonly related to montane environments of the Andes (Amat, 2009), as in Venezuela where it was recorded in the Merida cordillera and the Venezuelan coastal range at intermediates elevations (Velásquez *et al.*, 2017). In the Sierra Nevada de Santa Marta it was hemisynanthropic and common in the range of 700-800m, whereas it was sporadic in the Páramo ecosystem at 3000m (Amat, Perez-Hoyos & Alvarez in press). In the Brazilian Amazon it was one of the dominant species (Amat *et al.*, 2016). In the Northwest South America, it occurs in all natural region except in the Tepuyan (Figure 9) in the range of 50 to 3235m (Figure 2) clearly eurythermal and according the localities reviewed avoiding urban enviroments. The detailed morphology of this species may be consult in (Dear, 1985) who commented the high polymorphic variation of this species. Based on this argument and considering the wide range of its altitudinal distribution, it is possible that bionomics of isolated populations may display remarkably differences. the morphological identification of adults may follows the keys of Dear (1985). The immature stages were studied and described by Greenberg & Szyska (1984), as *H. flavifacies* and Colombian specimens by Florez & Wolff (2009).

Specimens examined. (549 males, 946 females) **Brazil** (18 males, 23 females) (1 female) Amazonas. Barcelos. Rio Demeni Alubiá. 2008-08. Arm[adilha] Malaise. Leg. A. Silva, R. Machado. Det. A. Pérez & E. Amat 2017 (INPA); (1 male) Amazonas. Manaus. Est[rada]. Am 10 Km 16. 1969-07-16. Leg. E. V. Silva. Det. A. Pérez & E. Amat 2016. 2902 (INPA); (1 female) Same data except Est[rada]. Am 1 Km 34. 1968-07-13. Leg. A. Faustino. 2872 (INPA); (1 female) Same data except Est[rada]. Am 1 Km 130. 1965-10-02. Leg. Flavio e Antônio. 2734 (INPA); (1 female) Amazonas. Manaus. Reserva Florestal Adolpho Ducke. 2°52'52.00"S; 59°57'12.16"W 1963-05-25. Leg. V. Cambibel. Det. A. Pérez & E. Amat 2017. 2937 (INPA); (1 male, 3 females) Same data except 1970-07-04. Leg. L. Albuquerque. Det. A. Pérez & E. Amat 2016. 300 (INPA); (1 male) Same data except 4°55'54.0"S; 59°58'25.0"W. 2014-07-18. Leg. E. Amat & A Pérez. Det. A. Pérez & E. Amat 2017. RADT02 (INPA); (1 female) Same data except 1988-11-17. Leg. Y. Camara & J.E. Binda (INPA); (1 female) Same data except 1989-03-02; 1989-03-09 (INPA); (1 male) Same data except 1989-01-06; 1989-01-12. (INPA);(1 male, 1 female) Same data except 1989-01- 19; 1989-01-26 (INPA); (2 females) Same data except 1988-10-27 (INPA); (1 male, 1 female) Same data except 1988-12-17 (INPA); (1 male) Same data except Est[rada]. Am 010 Km 26. 1978-03-11. Leg. L. Albuquerque (INPA); (1 female) Same data except 2° 55'51"S; 59°58'29"W. 1999-07-05; 1999-07-07. Shanon-Carniça. Leg. Pes, A.MO. Det. A. Pérez & E. Amat 2017. 1315 (INPA); (3 males, 2 females) Amazonas. Manaus. Estación investigación. INPA. 2°38′.14.2"S; 60°09′27.0"O. 2013-12-05. ZF2T06. T[rampa] V[an] S[omeren] R[ydon]. 72h[oras]. Leg. E. Amat. Det. A. Pérez & E. Amat 2017 (INPA); (1 female) Same data except INPA Campus II. 3°5′47"S; 59°59′22"w.2008-01-02. Leg. Souza, A.B. Det. Souza, A.B (INPA); (8 males, 3 females) Same data except Campus Univiversitario MAO. 3° 5'47.09"S; 59°58'10.06"W. 1988-08-05; 1988-07-28. Leg. Marcia Castilho, J. Elias Binda. Det. A. Pérez & E. Amat 2017 (INPA); (1 female) Amazonas. Novo Airã. Rio Jau, Meriti. 1°51'10.66"S; 62° 9'0.03"O. 1994-06-04; 1994-06-10. Leg. J.A. Rafael (INPA); (1 female) Amazonas. P[ar]q[ue] Nac[ional]. Jau. Carabinani. 3°13'59.17"S; 61°56'43.31"O. 1995-05-03, 1995-04-27. Leg. J.A. Rafael, J. Vidal (INPA); (1 female) Same data except 4°55'54.0"S; 59°58'25.0"W. 1994-06-20; 1994-06-29. Leg. L.S Aquino. Det. A. Pérez & E. Amat 2017 (INPA). **Colombia** (82 males, 301 females) (1 male) Amazonas. La chorrera. Camino Juan. 130m. 2015-05-14. Zona 3 T01. T[rampa] V[an] S[omeren] R[ydon]. 72h[oras]. Leg. E.

Kuiro. A. Pérez & E. Amat 2015 (CETdeA); (1 female) Same data except Zona 3 T[rampa]04 (CETdeA); (3 females) Same data except 1°27'30.75"S; 72°47'29.78"W. 140m. 2015-05-04. Zona 2 T02 (CETdeA); 1 female) Same data except Zona 2 T[rampa]04 (CETdeA);(1 female) Amazonas. Carretera los kms, km5. 4°10.096′S; 69°56.563′O. 124m. 2013-11-22. BS0101. T[rampa] V[an] S[omeren] R[ydon]. Leg. Del Aguila R, Pérez J & Varela A. Det. A. Pérez & E. Amat 2013 (CETdeA); (1 female) Same data except 2013-11-24. BS0102 Leg. Gómez-P L, Amat E, Del Aguila R, Pérez J & Varela A (CETdeA); (1 female) Same data except Carretera los kms, km5. 4°10.113′S; 69°56.591′O. 104m. BS0502 (CETdeA); (1 female) Amazonas. Estación Biologica. El Zafire. 4° 0'0.00"; 69°53'57.00"W. 120m. Botella modificada cebada con cabeza de pescado. 2007-12-04. Leg. E. Amat & L Franco. Det E. Amat 2011. 111137 (IAvH-E); (1 female) Same data except 111136 (IAvH-E); (1 female) Same data except 111135 (IAvH-E); (2 male, 3 females) Amazonas. Mocagua. 3°49.114′S; 70°14.503′O. 77m.BP0502. 2013-11-27. T[rampa] V[an] S[omeren] R[ydon]. Leg. Amat E & Del Aguila L. Det. A. Pérez & E. Amat 2013 (CETdeA); (1 male, 9 females) Same data except 3°49.201′S; 70°14.511′O. 80m. 2013-11-25. BP0401. Leg Del Aguila L (CETdeA); (1 male, 10 females) Same data except 2013-11-25. BP0402 Leg. Amat E & Del Aguila L (CETdeA); (1 female) Same data except 3°49.411′S; 70°14.620′O. 93m. BP0302. 2013-11-27. Leg. Amat E & Del Aguila L (CETdeA); (1 male, 6 females) Same data except 3°49.265′S; 70°14.581′O. BP0101. 97m.2013-11-25. Leg. Del Aguila L (CETdeA); (1 male, 1 female) Same data except 2013-11-27. BP0102. Leg. Amat E & Del Aguila L (CETdeA); (1 female) Same data except 3°49.348′S; 70°14.509′O. 122m. 2013-11-25. BP0201. Leg. Del Aguila L (CETdeA); (1 female) Same data except 2013-11-27. BP0202. Leg. Amat E & Del Aguila L (CETdeA); (2 males, 4 females) Casanare. Tamara. San Pedro. 5°45'26.35"N; 72°12'45.00"W. 560m. 2016-05-17. PMT-BdG-VSRDip01. T[rampa] V[an] S[omeren] R[ydon]. 48h[oras]. Leg. L.E. Franco & F. Velandia. Det. A. Pérez & E. Amat 2016. Temp-ACF449 (IAvH-E); (4 females) Same data except PMT-BdG-VSRDip02. Temp-ACF451 (IAvH-E); (1 female) Same data except 5°44'54.73"N; 72°12'55.09"W. 590m. PMT-B-VSRDip01. Temp-ACF454 (IAvH-E); (3 males, 1 female) Same data except PMT-B-VSRDip02. Temp-ACF455 (IAvH-E); (1 male, 12 females) Same data except PMT-B-VSRDip03. Temp-ACF458 (IAvH-E); (1 male) Same data except 5°45'10.13"N; 72°12'38.53"W. 570m. PMT-Ptz-VSRDip01. Temp-ACF463 (IAvH-E); (1 male, 12 females) Same data except PMT-Ptz-VSRDip02. Temp-ACF465

(IAvH-E); (2 males, 20 females) PMT-Ptz-VSRDip03. Temp-ACF468 (IAvH-E); (3 males, 3 females) Chocó. Bahia Solano. 06° 15' 57.9"; 77° 27' 16". 52m. 2013-09-25. BSPLT02. T[rampa] V[an] S[omeren] R[ydon]. Leg. Pérez J, Gómez LM y Quiroz M. A. Pérez & E. Amat 2013 (CETdeA); (2 female) Same data except 06°16'13.2"; 77°27' 27.5'. 53m. BSUT14. (CETdeA); (1 male, 6 females) Same data except 06°16' 18.3"; 77°27' 33.6". 53m. BSUT15 (CETdeA); (1 male, 1 female) Same data except Playa Huina. 06° 16' 25.2"; 77°27' 36.1". 56m. BSUT16 (CETdeA); (1 male, 3 females) Same data except Bahia Solano. 06°15'57.0"; 77°27'12.4'. 88m. BSPLT08 (CETdeA); (2 females) Same data except 06°15' 52.0"; 77°27' 13.6". 94m. BSPLT06 (CETdeA); (4 males, 12 females) Same data except 06°16' 22.7"; 77°27' 39.6". 100m. BSPLT10 (CETdeA); (1 male) Same data except 06°15'50.8"; 77°27' 14.5". 109m. BSPLT05 (CETdeA); (1 male, 5 females) Same data except 06°16'24.5"; 77°27' 44.6". 150m. BSPLT11 (CETdeA); (3 males, 7 females) Same data except 06°16' 25.0"; 77°27' 47.2". 180m. BSPLT12 (CETdeA); (1 female) Cundinamarca. La Mesa. °39'0.45"N; 74°27'4.52"W. 1150m. 2002-12-18. Det. E. Amat 2011. 54470 (IAvH-E); (1 female) Same data except 54471 (IAvH-E); (1 female) Cundinamarca. Quipile. Finca El Cajón. 4,73565; -74.538079. 1250m. Leg. L. Mendoza. Det. E. Amat 2011. 111134 (IAvH-E); (1 male) Magdalena. Cincinati. 11° 6′ 6,8″N; 74° 4′52,3″W. 1433m. 2013-03-02. SMT 01. Leg. Amat, E. Utria, G & Pérez L. Det. A. Pérez & E. Amat 2013 (CETdeA); (1 female) Magdalena. Santa Marta. Minca. La Victoria. 11° 7'23.19"N; 74° 5'46.33"W. 940m. 2005-11-11. Leg. G. Amat. Det. E. Amat 2011. 111138 (IAvH-E); (1 female) Same data except 111139 (IAvH-E); (4 females) Magdalena. Las Tinajas. 11°15'30.50"N; 74° 4'32.80"W. 388m. 2013-03-03. SMT 09. T[rampa] V[an] S[omeren] R[ydon]. Leg. Amat, E. Utria, G y Pérez L. Det. A. Pérez & E. Amat 2013 (CETdeA); (3 females) Magdalena. Minca. 11° 8'34.20"N; 74° 6'31.50"W. 768m. 2013-03-02. SMT 05. T[rampa] V[an] S[omeren] R[ydon]. Leg. Amat, E. Utria, G & Sepúlveda P. Det. A. Pérez & E. Amat 2013 (CETdeA); (10 males, 64 female) Same data except 11° 7'57.20"N; 74° 7'7.80"W. 708m. SMT 06. Leg. Amat, E. Utria, G & Pérez L (CETdeA); (2 males, 3 females) 11° 9'22.30"N; 74° 8'7.80"W. 465m. SMT 07. Leg. Amat, E. Utria, G & Pérez L (CETdeA); (4 females) Magdalena. Vira Vira. 11°14'9.80"N; 74°4'17.00"W. 2592013-03-03. SMT 12. T[rampa] V[an] S[omeren] R[ydon]. Leg. Amat, E. Utria, G & Perez L. Det. A. Pérez & E. Amat 2013 (CETdeA); (14 males, 38 females) Meta. San Martin. La Novilla. 03° 32’ 00.2’; 73° 23’ 21.0’’. 244m. 2013-06-06. LNMT13.

T[rampa] V[an] S[omeren] R[ydon]. Leg. Pérez J & Gómez-Pinerez LM. Det. A. Pérez & E. Amat 2013 (CETdeA); (2 males, 4 females) Same data except 03° 31’ 59.2’’; 73° 23’ 19.0’’. LNMT16 (CETdeA); (8 males, 17 females) Same data except 03° 31’ 41.8’’; 73° 24’ 15.4’’. 249m. LNBT02 (CETdeA); (12 males, 20 females) Same data except 03° 31’ 59.8’’; 73° 23’ 59.0’’. LNPT05 (CETdeA); (1 female) Same data except 03° 32’ 09.1’’; 73° 23’ 27.6’. 256m LNST11. (CETdeA). **Ecuador** (447 males, 616 females) (6 males, 10 females) Napo. Baeza. 0°28'2.31"S; 77°53'33.65"O. 1948m. 2015-10-31. P2. Leg. M. Domínguez. Det. M. Domínguez 2015 (QCAZ-I); (1 male, 3 females) Same data except 2015-01-11 (QCAZ-I); (2 females) Napo. Sarayacu. 0°41'43.18"S; 77°48'1.37"W. 1312m. P3. T[rampa] V[an] S[omeren] R[ydon]. 2015-10-30. Leg. M. Domínguez. Det. M. Domínguez 2015 (QCAZ-I); (1 male, 2 females) Napo. Tena. 0°59'56.74"S; 77°50'11.89"W. 561m. 2015-10-29. P4. Leg. M. Domínguez. Det. M. Domínguez 2015 (QCAZ-I); (1 male, 4 females) Same data except 2015-10-30. P4 (QCAZ-I); (2 females) Pichincha. Cantón. Quito Parroquia de Amaguaña. Amaguaña. 0°22´46.58´´S; 78°29´42.53´´O. 2592m. 2016-06-29. ART01. T[rampa] V[an] S[omeren] R[ydon]. Leg. A. Torres. Det. A. Torres 2016 (QCAZ-I); (127 males, 160 females) Same data except 0°23´06.82´´S; 78°29´23.33´´O. 2618m. ART02 (QCAZ-I); (2 females) Pichincha. Cantón. Quito. Parroquia Alangasi Ilaló. 0°14´21.19´´S; 78°24´24.94´´O. 2728m. 2016-06-17. IBT02. T[rampa] V[an] S[omeren] R[ydon]. Leg A. Torres. Det. A. Torres 2016 (QCAZ-I); (6 females) Pichincha. Cantón. Quito. Parroquia de Lloa. Valle Lloa. 0°14´41.24´´S; 78°33´28.94´´O. 3157m. LBT03. 2016-06-29. T[rampa] V[an] S[omeren] R[ydon]. Leg. A. Torres. Det. A. Torres 2016 (QCAZ-I); (2 females) Same data except 0°14´52.05´´S; 78°33´52.16´´O. 3235m. LBT04. (QCAZ-I); (1 male, 2 females) Pichincha. Cantón. Quito. Parroquia de Puembo. Puembo. 0°12´10.46´´S; 78°19´42.28´´O. 2592m. 2016-06-29. PRT03. Leg. A. Torres. Det. A. Torres 2016 (QCAZ-I); (10 males, 16 females) Same data except 0°11´58.91´´S; 78°19´59.97´´O. 2554m. PRT04. (QCAZ-I); (67 males, 106 females) Pichincha. DMQ. Bosque metropolitano del sur. 0°20'34.84"S; 78°31'08.77"O. BMS-BT05. T[rampa] V[an] S[omeren] R[ydon]. Leg. A. Torres . Det. A. Torres 2016 (QCAZ-I); (233 males, 294 females) Pichincha. DMQ. Cashapamba. 0°21'24.17"S; 78°24'58.53"O. 2684m. 2019-08-23. C-R-T05.T[rampa] V[an] S[omeren] R[ydon]. Leg. A. Torres. Det. A. Torres 2016 (QCAZ-I); (2 females) Pichincha. DMQ. Quito. 0°12'38.61"S; 78°29'26.08"O. 2812m. 2016-08-17. QUT05. Leg. A. Torres. Det. A. Torres 2016 (QCAZ-I);

(1 female) Pichincha. Nanegalito. 0°04'00"N; 78°40'50"W. 1500m. Leg. R. León. Det. E. Amat 2014. QCAZ I 14785 (QCAZ-I); (1 female) Same data except QCAZ I 14786 (QCAZ-I); (1 female) Pichincha. Mindo. 0°02'54"S; 78°46'21"W. 128m. Leg. C. Altamirano. Det. E. Amat 2014 (QCAZ-I). **Venezuela** (2 males, 6 females) (1 male) Amazonas. Piedra del Cocuy. 150m. 1982-11-17. Leg. A. Chacon. Det. E. Amat 2012 (MIZA); (1 female) Aragua. Colonia Tovar. 1800m. 1969-08-13. Leg. J & B Bechyne. Det. E. Amat 2012 (MIZA); (1 female) Aragua. El Limon. 450m. 1976-06-01. Leg. F. Fernández Y. Det. E. Amat 2012 (MIZA); (1 male) Aragua. Maracay. Pozo Diablo. 10°18'14.57"N; 67°36'5.22"W. 500m. 1980-11-24. Leg. F. Fernandez Y. Det. E. Amat 2012 (MIZA); (1 Female) Aragua. Tiara. 700m. Malaise Tram[pa]. 1983-02-05Leg. A. Chacón. Det. E. Amat 2012. (MIZA); (1 female) Bolívar. Nuria. 500m. 1975-05-31. Det. E. Amat 2012 (MIZA); (1 female) Miranda. El Haltillo. 1000m. 1974-11-15. Det. E. Amat 2012 (MIZA); (1 female) Trujillo. Betijoque. La Gira. 500m. Leg. J Clavijo, J De Mamels, J Garcia, A. Chacon. 1996-12-04; 1996-12-09. Det. E. Amat 2012 (MIZA).

Paralucilia **Brauer & Bergenstamm, 1891**

Paralucilia fulvinota **(Bigot, 1877)**

(Figures 2, 11)

This is a widespread neotropical species distributed from Mexico to Chile (Dear, 1985; Mariluis *et al.*, 1994a). In Peru it was a relatively common fly in some sites, mainly premontane; from 200 to 1900m altitude where it was asynanthropic (S.I= -70) (Baumgartner & Greenberg, 1985). In Colombia it was recently reported at intermediate elevations of the Andes (Wolff & Kosmann, 2016), while in Venezuela at lower altitudes in the west of the coastal range (Velásquez *et al.*, 2017). In the Sierra Nevada de Santa Marta it was asynanthropic (S.I= -70) and common in the range of 700-800m closely related to premontane moist forest and montane wet forest (Amat, Perez-Hoyos, & Rafael in press.). In the Northwest South America, it occurs in the Andean and Caribbean region, mainly related to montane environments (Figure 11) at both sides of the foot hills of the Andes and in the Venezuelan coastal range from 90 to 1570m altitude (Figure 2). The morphology of this species is detailed in Dear (1985), although a reliable identification might be tricky since

Mariluis *et al.* (1994a) distinguished two color forms in this region; a light and a dark form living in sympatry. the morphological identification of adults may follows the keys of Dear (1985) or Mello (1996). The immature stages were studied and described by Greenberg & Szyska (1984).

Specimens revised (30 males, 77 females) **Brazil** (3 males) (1 male) Brasil, Amazonas, Manaus, Reserva Forestal Adolpho Ducke. 90m. x-xi.2014. 2°55'54.00"S-59°55'54.53"W, Sales T. leg. Mello R de P 2015 det. #150. (INPA). (1 male) Brasil, Amazonas, Manaus, Reserva Forestal Adolpho Ducke. 90m. x-xi.2014. 2°55'54.00"S-59°55'54.53"W, Sales T. leg. Mello R de P 2015 det. #155. (INPA). (1 male) Brasil, Amazonas, Manaus, Reserva Forestal Adolpho Ducke. 90m. x-xi.2014. 2°55'54.00"S-59°55'54.53"W, Sales T. leg. Mello R de P 2015 det. #156. (INPA). **Colombia** (24 males, 73 females) (1female) Magdalena Santa Marta S[ierra]N[evada de] S[anta]M[arta]- Cincinati. 1433m. 11° 6'6.80"N 74° 4'52.30"W. 2.iii.2013. E. Amat G. Utria L. Perez Leg. Det. A. Perez 201. TdeA10034 (CeTdeA). (1female) same data except TdeA10035 (CeTdeA). (1female) same data except TdeA10036 (CeTdeA) (1female) same data except: det. E. Amat 2013 TdeA10056 (CeTdeA) (4 males, 21 females) Magdalena Santa Marta. S[ierra]N[evada de] S[anta]M[arta] Cincinati. 11° 6′ 6,8″N-74° 4′52,3″W. Bosque humedo tropical. 1433m. V[an]S[omeren]R[ydon] 48h. SMT01. Amat, E. Utria, G y Perez L. Leg. 2.iii.2013. det E. Amat 2013 (CeTdeA). (5 females) Magdalena Santa Marta. S[ierra]N[evada de] S[anta]M[arta] Cincinati. 11° 6′ 11° 6'6.94"N 74° 4'52.69"W. Bosque humedo tropical. 1427m. V[an]S[omeren]R[ydon] 48h. SMT02. Amat, E. Utria, G y Sepulveda, P. Leg. 2.iii.2013. det E. Amat 2013 (CeTdeA). (5 females) Magdalena Santa Marta. S[ierra]N[evada de] S[anta]M[arta] Cincinati. 11° 5'43.39"N-74°; 4'36.73"W. Bosque humedo tropical. 1570m. V[an]S[omeren]R[ydon] 48h. SMT04. Amat, E. Utria, G y Perez L. Leg. 2.iii.2013. det E. Amat 2013 (CeTdeA). (6 males, 12 females) Magdalena Santa Marta. S[ierra]N[evada de] S[anta]M[arta] Minca. 11° 8'34.20"N 74° 6'31.50"W. Bosque humedo montano bajo. 768m. V[an]S[omeren]R[ydon] 48h. SMT05. Amat, E. Utria, G y Sepulveda, P. Leg. 2.iii.2013. det E. Amat 2013 (CeTdeA). (11males,16 females) Same data except: 708m. 11° 7'57.20"N -74° 7'7.80"W. SMT06. (CeTdeA). (1 female) Same data except: 465m. 11° 9'22.30"N 74°8'7.80"W. SMT07. (CeTdeA). (3 males, 2 females) Magdalena. Santa Marta. ver. Las Tinajas. 388m. 11°15'30.50"N 74° 4'32.80"W. Bosque seco tropical. Amat, E. Utria, G y Perez L. Leg. 3.iii.2013. V[an]S[omeren]R[ydon] 48h. Det. E. Amat 2013. SMT09 (CeTdeA). (3 females) same data except: 390m. 11°15'14.60"N-74° 4'25.80"W. SMT10. (CeTdeA). (1 female) same data except: ver. Vira Vira. 259m. 11°14'9.80"N-74° 4'17.00"W. SMT10. (CeTdeA). (1 female) Cundinamarca. La Mesa. 1200m.18-xii-2002. Ariza M leg. Trampa de carroña0031. 4.638921;-74.456100. det. Amat E 2013. IAvH-E 111240 (IAVH-E). (1 female) same data except: Trampa de carroña0023. IAvH-E 111237 (IAVH-E). (1 female) Caldas Norcasia. Sector El Tigre. 20135.566348; -74.896079. 800m. Forero F. Leg.VSR24h. []det E. Amat 2013. IAvH-E 111239 (IAVH-E). (1 male) same data except IAvH-E 111238 (IAVH-E). **Ecuador** (2 males, 2 females). (2 males, 2 females) Napo Tena Via Muyuna. 0°55'51.94"S 77°52'50.51"W. 700m. 03.vii.2016. V[an]S[omeren]R[ydon] 48h E. Amat y A. Perez. Leg. Det. E. Amat 2016 (CETdeA). **Venezuela** (1 male, 1 female) (1 female) Trujillo.La Gira. Cerca Betijoque. 500m. J. Clavijo-J DE Mamels, J Garcia, A. Chacon Leg. 4.9-xii-1996. 9°19'53.67"N 70°44'6.63"W. det. E. Amat 2011 (MIZA). (1 male) Miranda P[arque] N[acional]. Guatopo. 10° 2'35.28"N; 66°26'32.09"W. 500m.8-x-1980 A. Chacon Leg. Det, E. Amat 2011(MIZA).

Paralucilia paraensis **(Mello, 1969)**

(Figures 2, 11)

This is a neotropical species distributed from Costa Rica to Brazil (Dear, 1985; Mariluis *et al.*, 1994a). In Colombia it was reported in the eastern foothills of the Andean region (Amat 2009; Wolff & Kosmann, 2016) it was relatively common species in the Brazilian Amazon (E. Amat *et al.*, 2016), where it was hemysinanthropic (Sales, Ferreira-Keppler, Oliveira-da-Silva, & Souza, 2013). Surprisingly it was not encountered in the study of Baumgartner & Greenberg (1985) in Peru, neither in Venezuela by Velásquez *et al.* (2017). In the Northwest South America, it occurs in the Amazon and the Andean region where it was most commonly collected in the low lands of the Brazilian Amazon (Figure 11) in the range of 45-700 m (Figure 2). The detailed morphological description and the identification of adults may be consulted in Mello (1969) (as *Myolucilia paraensis*) or in Dear (1985) (as *Paralucilia adespota*). Some aspects of the life cycle of the Amazonian populations and their immatures stages were described by Sales *et al.* (2013).

Specimens examined (87 males, 82 females) **Brazil** (84 males, 74 females) (1 male) Amazonas Manaus INPA Campus II Urbano 3°5'47"S, 59°59'22"W. 2008-01-03. Leg. Souza A.B. det. Souza A.B. 2008 (INPA); (1 female) Amazonas Amanã2°40'37.28"S 64°39'20.26"W. 1979-09-21 Leg. Robin Best. det. E.Amat & A.Pérez 2016 (INPA);(1 female) same data except. Lago amaña (INPA); (1 female) Amazonas Manaus Est. Am 1. Km 64 aprox rio preto da eva. 2°40'5.14"S, 59°39'30.76"W. 1970-08-27. Leg. A. Faustino. Det. E.Amat & A.Pérez 2016 3016. (INPA); (1 female) Amazonas Manaus Est. Am 1. Km 15. 1970-07-31 leg. A. Faustino. Det. E.Amat & A.Pérez 2017 - 3006 (INPA); (4 males, 2 females) Amazonas Manaus Reserva Florestal Adolpho Ducke. 2°52'52.00"S, 59°57'12.16"W. leg. L.Albuquerque. 1978-01-15 det. E.Amat & A.Pérez 2017 (INPA); (3 females) Amazonas Tefé Campus Instituto Mamirauá In dead Dolphin. 3°21'18.89"S, 64°43'50.38"W.105m leg. D. Mendes. 2016-10. Det, E.Amat & A.Pérez 2017(INPA); (3 males, 1 female) Amazonas Manaus Estação de pesquisa ZF2-INPA. 2°38′.14.2"S, 60°09′27.0"O leg. E. Amat. 2013-12-05. V[an]S[omeren]R[ydon]. 72h[oras] det, Amat E. ZF2T06 (INPA); (1 male, 1 female) Amazonas Manaus REMAN-SUL 03°08'15"S a 19",59°57'21"W a 26" Leg. N. Aguilar; TL Gualerto, AW Gomes;MDM Raizer; ML Jurema. 2 Armadilha de Shannon.2006-09-28, 2006-10-27, 2006-09-14. Det E. Amat & A.Pérez 2017 (INPA); (1 male) Amazonas ZF2 2°38'14.06"S, 60° 9'27.06"W x-xi.2014 leg. Sales T. 110m TL151 Det. Mello 2014 (INPA); (1 male) Amazonas Reserva Forestal Adolpho Ducke. 2°55'54.00"S, 59°55'54.53"W. 90m. leg. Sales T. x-xi.2014. det. Mello 2014 as *P. pseudolyrcea* TL152 (INPA); (1 female) Amazonas Novo Airão. 2°42'42.19"S, 60°57'17.66"W. 60m. 7-8.xii.2013. Leg. Amat E & Marinho M. Navt.3 V[an] S[omeren] R[ydon] 48h[oras] det. E. Amat & A.Pérez 2013. (INPA); (3 females) Amazonas Novo Airão 2°42'17.45"S, 60°57'11.09"W. 74m. 7-8.xii.2013. Amat E & Marinho. Navt 4. V[an]S[omeren]R[ydon] 48h[oras] det. E. Amat & A.Pérez 2013. (INPA); (4 males, 4 females) Amazonas Novo Airao2°49'0.65"S, 60°55'9.42"W. 50m. 8.xii.2013. Amat E & Marinho M. Navt.1. V[an]S[omeren]R[ydon] 48h[oras] det. E. Amat & A.Pérez 2013. (INPA); (1 male, 2 females) Amazonas Novo Airão 2°38'28.33"S, 60°56'21.68"W.50m. 7-8.xii.2013. Amat E & Marinho M. Navt.5. V[an]S[omeren]R[ydon] 48h[oras] det. E. Amat & A.Pérez 2013. (INPA); (1 male, 4 females) Amazonas Manaus INPA. ZF2. 2°35'19.98"S, 60° 6'59.44"W. 120m. 2.xii.2013. leg. E. Amat. V[an]S[omeren]R[ydon] 48h[oras] Det. E. Amat

& A.Pérez 2015. ZF2T3.02. (INPA); (1 female) Amazonas Manaus INPA. ZF2. 2°38'16.61"S, 60° 9'22.70"W.106m. 3.xii.2013. leg. E. Amat. V[an]S[omeren]R[ydon] 48h[oras]. Det. E. Amat & A.Pérez 2015. ZF2T4.01.(INPA); (58 males, 47 females) Amazonas Manaus INPA. ZF2. 2°38'14.06"S,60° 9'27.06"W. 115m. 3.xii.2013. leg. E. Amat. V[an]S[omeren]R[ydon] 48h[oras]. Det. E. Amat & A.Pérez 2015. ZF2T6.01.(INPA); (1 male) Amazonas Castanho Careiro 3°40'37.43"S, 60°19'54.22"W 45m. 12-13.xii.2013. leg. Marinho M & F Filho. V[an]S[omeren]R[ydon] 48h[oras]. Det. E. Amat & A.Pérez 2015. Det. E. Amat & A.Pérez 2015. CAC-T2. (INPA); (6 males, 2 females) Amazonas Castanho Careiro 3°40'43.53"S, 60°19'36.83"W 45m. 12-13.xii.2013. leg. Marinho M & F Filho. V[an]S[omeren]R[ydon] 48h[oras]. Det. E. Amat & A.Pérez 2015. Det. E. Amat & A.Pérez 2015. CAC-T3. (INPA); (2 males, 1 female) Amazonas Castanho Careiro 3°40'39.18"S, 60°19'42.35"W. 45m. 12-13.xii.2013. leg. Marinho M & F Filho. V[an]S[omeren]R[ydon] 48h[oras]. Det. E. Amat & A.Pérez 2015. Det. E. Amat & A.Pérez 2015. CAC-T5. (INPA); **Colombia** (3 males, 5 females) (1 female) Amazonas Leticia Km8. 80m. Amazon rain forest (clearance). 4°10'0.96"S; 69°56'56.30"W. 24.xi.2013. E. Amat, R.del Aguila, J.Peréz, L. Piñerez, A.Varela Leg. Det E. Amat 2013. TdeA10040 (CETdeA); (1 female) same data except TdeA10039 (CETdeA); (1 female) same data except TdeA10059 (CETdeA); (1 female) same data except TdeA10060 (CETdeA); (1 male) Vichada Cumaribo Selva de Mataven. 4° 8'21.39"N, 68°53'49.20"W.145m. Leg, L. E. Galeano. 22-04-2007. Trampa excremento humano. Det E. Amat 2013. IAvH-E111243 (IAvH-E); (1 male) same data except IAvH-E111241. (IAvH-E); (1 female) same data except IAvH-E111242. (IAvH-E); (1 male) same data except IAvH-E111244. (IAvH-E); **Ecuador** (1 female) Napo TenacVia Muyuna. 700m. Foothill Andean forest. 0°55'51.94"S, 77°52'50.51"W. V[an]S[omeren]R[ydon] 48h[oras]. 04.vii.2016. leg. E. Amat y A. Perez. TL240. det. E. Amat & A.Pérez. TdeA10058 (CETdeA); **Venezuela** (2 females) (1 female) Amazonas Piedra del Cocuy. 17-xi-1982. Leg. G Yepez & A. Chacon. Det. E. Amat 2012. (MIZA); (1 female) Amazonas Rio Autana 100m leg. J M Cruxent. 2xii-1948. Det. E. Amat 2012. (MIZA).

Luciliinae

Blepharicnema Macquart, 1843

Blepharicnema splendens Macquart, 1843:284

(Figures 2, 12)

This is an endemic Andean species distributed from Venezuela to Bolivia (James, 1970; Mariluis & Peris, 1984). Its geographical distribution was corroborated by Amat & Wolff (2007), reporting it as rare and asynanthropic in the Andean forest up to 2500 m altitude. Recently it was recorded in the Sierra Nevada de Santa Marta as an exclusive species of the montane rain forest (Amat, Perez-Hoyos, & Rafael in press), as it was reported in the Merida Cordillera and in the Venezuelan coastal range (Velásquez *et al.*, 2017). In the Northwest South America, it occurs along the Andean and the Caribbean region (Figure 12) at the range of 1100 to 2540 m (Figure 2). It is a robust fly probably the largest blow fly in the neotropics, the detailed morphological description and the identification of adults may be consulted in the redescription of Mariluis (1979) or the identification key of Amat *et al.* (2008). The bionomical aspects and life cycle have not been studied. The immature stages of this species are unknown.

Specimens examined. (14 males; 43 females)
Colombia (7 males, 2 females): (1 female) Risaralda. Pereira. P[arque] N[acional] N[atural] Ucumari.N04°42'30,42";W 75°29'13,20". 2019-05-29. Col. Pérez,S. Manual. E. Amat det.2015 (UPTC); (1 male) Boyacá. Villa de Leyva S[antuario]F[auna]F[lora] Iguaque. 3000m. 2006-11-08. Arias, J. Leg. Van Someren Rydon. E. Amat det.2015 (UPTC); (1 female) Risaralda. Pereira. S[antuario].F[auna].F[lora], Otún Quimbaya. Ucumarí la Pastora. 04°42'30,42"N W75°23'13,20". 2450m. 2012-05-31. J. Lopéz & M. Loaiza leg. Manual. E. Amat det.2015 (UPTC); (1 male) Cauca. Sector la Romelia. 2° 38' N; 76° 54' W. 2640m. 26/Mar/2004. H. Pino Leg. Malaise trap. E. Amat det.2015. IAVH-111030 (IAVH); (1 male) Valle del Cauca 3° 34' N; 76° 50' W. 2080m. 26/Jun/2004. S. Sarria. Malaise trap. E. Amat det.2015. IAVH-111029 (IAVH); (1 male) Cundinamarca. Fusagasugá. Inspección de policía La Aguadita. Finca La Carbonera. 4°29'5"N; 74°18'38"W. 2470m. 12/Jul/2006. F. Fernando Leg. Fish head trap. E. Amat det.2015. IAVH-111031(IAVH); (1 male) Magdalena. Santa Marta. El Ramo. 10°48'N; 73°39'W. 2500m. 30/Mar/2001. J. Cantillo Malaise Trap. E. Amat det.2015. IAVH-11027 (IAVH); (1 male) same data except IAVH-111028 (IAVH); (1 male) Putumayo. Mocoa 1°4'N; 76°44'W. 1850m. 01/Jan/1999. E. Gonzalez leg. Malaise Trap. E.

Amat det.2015. IAVH-111026 (IAVH); **Ecuador** (1male, 6 females): (1 female) Imbabura, Los Cedros, 1880 m[eters]a[bove] s[ea]l[evel], 15/8/2006, R. Cárdenas, QCAZ-II 224621, (QCAZ-I); (1 female) same data except QCAZ-II224622 (QCAZ-I); (1 female) same data except QCAZ-II224623 (QCAZ-I); (1 female) same data except QCAZ-II224624 (QCAZ-I); (1 female) same data except QCAZ-II12065 (QCAZ-I); (1 male), Zamora, Podocarpus, Romerillos, 2200 m[eters]a[bove] s[ea]l[evel], 31/8/1998, S. Noriega, MECN12313 (MECN); (1 female) Zamora, Podocarpus, La Curintza, 1787m, 3/9/1998, G. Estevez MECN 12194 (MECN); (1 female), Morona Santiago, Tinajillas, 4/3/1985, F. Brand MECN12246 (MECN); (1 female) Zamora, Podocarpus, Sendero Nangaritza, 3/9/1998, G Estevez MECN12198 (MECN). **Venezuela** (6 males, 35 females): (1 female) Aragua. P[arque]N[acional] Henri Pittier. Rancho Grande.1100m. 1951-05-25. F. Fernandez Y. leg., E. Amat det. 2012 (MIZA); (1 male) Trujillo-Portuguesa. Laguna de agua negra. Boconó. Biscucuy.1800m. 1992-04-12. M. Gaiani. Leg., E. Amat det. 2012 (MIZA); (2 males) Distrito Defederal. P[arque]N[acional] Cerro el Ávila El Ávila 1900m 1979-07-15. E. Amat det. 2012 (MIZA); (2 females) Distrito Federal. P[arque]N[acional] Cerro el Ávila. Los Venados. Serranía el Ávila. 1400m. 1958-10-12. C.J. Rosales., E. Amat det. 2012 (MIZA); (1 female) Aragua P[arque]N[acional] Henri Pittier. El Cenizo. 2200m. 1944-01-07. F. Fernandez. Y. E. Amat det. 2012 (MIZA); (1 female) Distrito Federal. . P[arque]N[acional] Cerro el Ávila. El Teleferico. 2130m. 1961-04-11. A. Dascoli. Col. E. Amat det. 2012 (MIZA); (2 females) Aragua. P[arque]N[acional] Henri Pittier. Choroni. Carrretera Maracay. 1500m. 1956-12-28. C.J. Rosales. E. Amat det. 2012 (MIZA); (2 males, 2 females) Aragua. Colonia Tovar. vía costa de maya. 2100m. 1996-11-28 J. DeMarmels-A. Chacón., E. Amat det. 2012 (MIZA); (1 female) Aragua. P[arque]N[acional] Henri Pittier Portachuelo. Rancho Grande.1100m. 1976-07-13J. Clavijo-I Jaspe. E. Amat. Det 2012 (MIZA). (1 female) Aragua. Portachuelo. Rancho Grande.1100m. 1976-08-29. J. Clavijo - Z. Hernandez. E. Amat. Det 2012 (MIZA). (3 females) Vargas. P[arque]N[acional] Pico Codazzi. Jenjibrillar. Geremba. 2300m. 1994.08.20 L. A. Campos. E. Amat. Det 2012 (MIZA). (3 females) Aragua. P[arque]N[acional]Henri Pittier. Rancho Grande. 1400m. 1997.nov.12-30. T. Pape Leg. T. pape. Det 1998 (MIZA). (2 females) Miranda P[arque]N[acional] El Ávila. Q. seca. 10°32'51,03" N; 66°51'53'6"W. 1972-04-28. E. Amat. Det 2012 (MIZA). (1 female) Barinas. La Chimenea. 1500m. 1973-06-1-6. J. Salcedo col. E. Amat. Det 2012 (MIZA). (1 male) Aragua. P[arque]N[acional] Henri Pittier.

Cumbre de Chorini. 1972-02-08. G. Ulloa., E. Amat. Det 2012 (MIZA). (2 females) Aragua. P[arque] N[acional] Henri Pittier Choroní. 1600m. 1949-05-21 F. Fernandez. E. Amat. Det 2012 (MIZA). (2 females) Aragua. P[arque]N[acional] Henri Pittier. Pico Guacamaya. 1800m. 1976-08-23 E. Amat. Det 2012 (MIZA). (2 females) Aragua. P[arque]N[acional] Henri Pittier. Pico Guacamaya. 1740m. 1993-12-02 F. Vasquez-J. Garcia. E. Amat. Det 2012 (MIZA). (2 females) Aragua. P[arque]N[acional] Henri Pittier. Carretera Maracay-Choroní. 1600m. 1945-09-03. R. Lichy. E. Amat. Det 2012 (MIZA). (1 female) Lara. P[arque]N[acional]. Yacambu. F. Gutierrez-F. Martinez. 1982-10-15. E. Amat. Det 2012 (MIZA). (1 female) Miranda. P[arque] N[acional]. El Ávila. E. Amat. Det 2012 (MIZA). (1 female) Miranda. P[arque]N[acional]. El Ávila. El Eden. 1975-05-15. E. Amat. Det 2012 (MIZA). (1 female) Barinas. Soledad Carretera.1100m.1974-08-22. B. Bechyne Leg. E. Amat. Det 2012 (MIZA).

Lucilia Robineau-Desvoidy, 1830

Lucilia albofusca Whitworth, 2014

(Figures 2, 14)

This is a recently described neotropical species, distributed from Panama to Peru including Brazil. It was the most common species collected in the French Guiana by its descriptor in 2008. The holotype material was collected related to swarms of army ants (*Eciton sp.*) (Whitworth, 2014). Surprisingly it was not cited in the catalogue of Colombia by Wolff & Kosmann (2016) neither in Venezuela by Velásquez *et al.* (2017). In the Northwest South America, it was found in the Amazonian, Pacific and Tepuyan regions; in the late region, it was related to the base of the Cerro de la Neblina Mountain while in the Amazon reaches the foothills of Andean mountain in Ecuador (Figure 14) below the 800m altitude (Figure 2). The detailed morphological description and the identification of adults may be consulted in the revision of Whitworth (2014); the immature stages of this species are unknown.

Specimens examined. (1 males, 50 females) **Brazil** (49 females) (1 female) Acre. Cruzeiro do Sul. Rio Moa. 07-37´02´´S; 72-46´15´´W. 217m. 1996-11-19;1996-09-28. Leg. JA. Rafael,

J. Vidal & RL. Menezes. Det. E. Amat 2016 (INPA); (3 female) Amazonas. Carabinani. Parque Nacional JAU. 50m. 1995-05-03; 1995-04-27. Malaise. Leg. JA. Rafael & J. Vidal. Det. E. Amat 2016 (INPA); (1 female) Same data except. Sitio Nunes. 01-40´31´´S; 61-46´34´´. 30m. 1995-09-20;1995-09-23 (INPA); (1 female) Same data except. 01-54´46´´S; 61-35´23´´W. 40m. 2001-04-08;2001-04-16. Leg. AL. Henriques & Vidal (INPA); (1 female) Amazonas. Manaus. Res[erva] DUCKE,Torre. 2°56'14.28"S; 59°56'15.59"W. 80m. 1994-08-05;1994-08-16. Leg. JA. Rafael & J. Vidal. Det. E. Amat 2016 (INPA); (39 female) Amazonas. Novo Aripuana. Reserva Soka. 05-15´53´´; 60-07´08´´. 53m. Malaise. 1999-05-05; 1999-04-28. Leg. RL. Ferreira, RA. Rocha, J. Vidal & RS. Leite. Det. E. Amat 2016 (INPA); (2 female) Amazonas. Novo Airao. Rio Jau. Meriti. 1°42'54.00"S; 61°54'32.00"W 45m. 1994-06-04;1994-06-10. Leg. JA Rafael. Det. E. Amat 2016 (INPA); (1 female) Roraima. Serra Pacaraima. 04-27´04´´N; 61-07´56´´800m. 1995-09-07;1995-09-01. Malaise. Leg. JA. Rafael, AL. Henríquez & J. Vidal. Det. E. Amat 2016 (INPA). **Colombia** (1 female) Vaupés. Taraira. Estación Biológica Mosiro-Itajura; Caparú. 1° 3'60.00"S; 69°30'60.00"O. 60m. Det. E. Amat 2016**.** IAvHE-111043 (IAvH-E). **Ecuador** (1 male) Orellana. E. C. Yasuni. 0°40'27.08"S; 76°23'48.98"O. 217m.2012-04-06. Leg. A. C. León. Det. E. Amat 2016 (QCAZ-I).

Lucilia cuprina **(Wiedemann, 1830)**

(Figures 2, 13)

This species is commonly known as the sheep blow fly, of worldwide distribution, in America from Southern United States to Argentina (James, 1970); in Australia is a myiasis-produced fly and presumably it was introduced to the New World in the last century (Zumpt, 1965). In Peru it was eurythermal, uncommon and eusynanthropic (S.I=+99), up to 3100 m altitude (Baumgartner & Greenberg, 1985). In Colombia it was reported in the central Andes by Wolff & Kosmann (2016), and recently in Venezuela at the northern of Merida cordillera and along the coastal range by Velásquez *et al.* (2017); all these records related to anthropogenic environments. In the Northwest South America, it is in all natural region except Pacific and Tepuyan (Figure 13), mainly below the 1496 m altitude (Figure 2). According to the data gathered for this area, it is remarkably related to human settlements; corroborating the eusynanthropic behave reported in Peru. For its veterinary, medical and economical importance an extensive literature is available about the ecological and bionomical aspects of this species. The detailed morphological description updated may be consulted in Williams & Villet (2014). the identification of neotropical adults may follow the keys of Whitworth (2010), (2014). The immature stages of Peruvian specimens were studied and described by Greenberg & Szyska (1984).

Specimens examined (25 males, 26 females) **Brazil** (1 male, 4 females): (1 male) Amazonas. Manaus. Feira do produtor. 56m. 2001.viii.27. Ale-Rocha, R., Soares, E.F. Leg. E. Amat Det. 2016 (INPA); (1 female) Same data except Feira da Compesa. 50m. 2001.viii.20 (INPA); (1 female) Same data except INPA V8. 3° 5'28.15"S; 59°59'37.83"W. 55m. 1989.vii.26. ISCA-BOFE. N.D. Paraluppi Leg. E. Amat det. 2016 (INPA); (1 female) Same data except Am 10 Km 45. 85m. 1982.iv.26. E.L Oliveira Leg. (INPA); (1 female) Reserva Florestal Adolpho Ducke Est. Am 10 Km 26. 2°52'52.00"S; 59°57'12.16"W. 1977. v.08. L.Albuquerque Leg. (INPA); **Colombia** (20 males, 18 females) (5 male, 14 females) Antioquia. Copacabana. Ankon. 06º22'07.1"N; 75º29'22.3"W. 1417m.10.iii.2010. 3CP1. M.A. Ramírez, C. Rave Leg. M.A. Ramírez Det 2010 (CETdeA); (1 male) Boyacá. Villa de Leyva. Casco Urbano. 2200m. 20/Jun/2005. Reyes Z. Leg. E. Amat Det 2009. 111004 (IAVH-E); (3 males) Same data except 111005. 111006. 111007 (IAVH-E); (1 male) Floridablanca. 840m. 31/Dec/2008. E. Amat Leg. E.Amat Det 2009. 111009 (IAVH-E); (1 male) La Belleza. 2189m. 04/Oct/2004. E. Amat Leg. E. Amat Det 2009. 111010 (IAVH-E); (1 male) Same data except 111003 (IAVH-E); (1 male) Medellín. Universidad de Antioquia. 1496m. 03/Apr/2007. Mcphail Modificada y cebada con cabeza de Hígado. E. Amat Leg. E. Amat Det 2009. 111011 (IAVH-E); (1 male) Neiva. Parque de los Periodistas. 454m. 12/Jun/2007. Manual sobre cabeza de Pescado. E. Amat Leg. E. Amat Det 2009. 111013 (IAVH-E); (1 male) Same data except 111012 (IAVH-E); (1 female) Tolima. Ambalema. 250m. red Entomologica. D. Angel Leg. E. Amat Det 2009 (UNAB); (1 female) Tolima. Flandes. 290m. O. Becerra. Leg. E. Amat Det 2009 (UNAB); (1 male) Tolima. Melgar. 320m. J. López. Leg. E. Amat Det 2009 (UNAB); (1 female) Valle del Cauca. Buga. 975m. Juncos. Trisot. Leg. E. Amat Det 2009 (UNAB); (1 female) Same data except 980m. C. Vanegas. Leg. (UNAB); (1 male) Villa de Leyva. Claustro San Agustin. 2200m. 03/May/2007. Trampa botella modificada y cebada con pescado. E. Amat Leg. E. Amat Det 2009. 111015 (IAVH-E); (2 males) Same data except. 111014. 111016 (IAVH-E); (1 male) Villa de Leyva. En Jardín. 2200m. 27/Apr/2005. Manual. Reyes Z. Leg. 111008. E. Amat Det. 2009 (IAVH-E). **Venezuela** (4 males, 4 females) (1 female) Anzoategui. El tigre. 260m. 25/08/1971. Exp Goanipa Leg. E. Amat Det 2011 (MIZA); (3 female) Caracas DF. DF.90m. 02/08/1994. L.A. Campos Leg. E. Amat Det 2011 (MIZA); (4 male) Caracas DF. DF. 880m. 24/07/1994. E. Amat Det 2011 (MIZA).

Lucilia eximia **(Wiedemann, 1819)**

(Figures 2, 15)

This is a species of the New World widespread distributed from southern United States to Chile (James, 1970). It is the most frequent species of *Lucilia* in the Neotropical region where it is remarkably variable in morphology and coloration (Whitworth, 2014). This author have revised 870 specimens from Mexico to Argentina detailing relevant geographical information. In Peru it was eusynanthropic (S.I=+77) and premontane (200-1900m) exclusive of the eastern slope of the Andes (Baumgartner & Greenberg, 1985). In Colombia it was recorded in all natural region but it was most common in the Andean region below 1650m altitude (Whitworth, 2014; Wolff & Kosmann, 2016), as well as in Venezuela occurring in the northern of the Merida cordillera and the coastal range (Velásquez *et al.,* 2017). Recently reported as eusynanthropic (S.I=+48) in the Sierra Nevada de Santa Marta, common in the range of 300-400m (Amat, Perez-Hoyos, & Rafael in press). In the Amazon region was one of the constant species in a recent survey of carrion feeding flies (Amat *et al.*, 2016), there it also was cited of forensic importance (Ururahy-Rodrigues *et al.,* 2013). In the Northwest South America, it occurs in all natural region excepting in the Tepuyan (Figure 15) up to 2780 m (Figure 2). For its medico-legal importance as well as its common presence in neotropical environments, a considerable literature of its biology, ecology and bionomical aspects are available mainly in the context of forensic entomology. Whitworth (2014) barcoded specimens coming from several localities of its distribution area; but not a unique monophyletic cluster was recovered. The author commented the possibility that those discrete groups formed may are acting as cryptic species, and according COI data *L. eximia* must be a species complex. For the above reasons it is strongly recommended to study the bionomical aspects of local populations separately, in order to apply appropriately the biology of this species in the legal context. The detailed morphological description, including the male and female genitalia together with the identification of adults may be consulted in the recent revision of the genus by Whitworth (2014). It is highly probably that before this revision, the identity of many Neotropical specimens belonging to sibling species (especially those with two postsutural acrostichal setae) were misidentified or determined as *L. eximia*, some studies could fall into these inaccuracies (Mariluis *et al.*, 1994b). The immature stages of Peruvian specimens were described by Greenberg & Szyska (1984) and those Colombian by Florez & Wolff (2009).

Specimens examined. (193 males, 171 females)

Brazil (3 male, 36 females) (6 females) Amazonas. Manaus. INPA Campus II. 3° 5'47"S; 59°59'22"W 1978-07-18. A.Y. Harada Leg. E. Amat & A. Pérez Det 2017 (INPA); (1 male) Same data. except. INPA. 3°5'47"S; 59°59'22"W. 1974-05-14. J. Arias Leg. (INPA); (1 female) Amazonas. Manaus. Reserva Florestal Adolpho Ducke. 2°52'52.00"S; 59°57'12.16"W. 1982-03-11. J.A. Rafael Leg. (INPA); (3 females) Same data. except. Km 26. 1988-12-13 J.A. Rafael Leg. (INPA); (1 females) Same data. except. 1988-09-22 (INPA); (2 males) Same data. except. 1968-11-28. Antonio Faustino Leg. 2888 (INPA); (1 female) Same data. except. Est[rada]. Am 1 Km 47. 1968-10-04. A. Faustino Leg. (INPA); (21 females) Same data. except. 1968-08-10. Est[rada]. Am 1 Km 134. 2863m (INPA); (2 females) Same data. except. Est[rada]. Am 1 Km 15. 1970-07-31. A. Faustino Leg. 3006 (INPA); (1 female) Roraima. Pacaraima. 4°11'13.23"N; 60°51'12.56"W. 644m. 1988-07-5, 1988-06-25. J.A. Rafael Leg. E. Amat & A. Pérez Det 2017 (INPA). **Colombia** (181 males, 112 females) **(**1 male, 1 female) Amazonas. Leticia. 8k. 4° 8'32.50"S; 69°56'39.60"W. 123m. 22.xi.2013. V[an] S[omeren] R[ydon] mod[ificada]. 48h[oras]. Del Aguila R, Pérez J & Varela A Leg. E. Amat & A. Pérez Det 2014 (CETdeA); (1 male, 1 female) Same data. except. 4°13.088' S; 69°56.471'. 153m. Pérez J. & Varela A. Leg. E. Amat & A. Pérez Det 2014 (CETdeA); (42 males, 18 females) Same data. except. 4°12.537' S; 69°56.645'. 81m. 24.xi.2013. E. Amat Leg. E. Amat & A. Pérez Det 2014 (CETdeA); (18 males, 5 females) Same data. except.

4°13.024' S; 69°56.468' O. 79m. 27.xi.2013 (CETdeA); (2 males, 2 females) Antioquia. Caldas. Caldas. 06°03'06.9" N; 75°37'19.2"O. 1840m. 13.xi.2010. V[an] S[omeren] R[ydon] mod[ificada]. 48h[oras]. Ramírez M., Durango Y., Areiza H Leg. E. Amat & A. Pérez Det 2011 (CETdeA); (2 males, 2 females) Same data. except. 8.xii.2010. (CETdeA); (2 males, 2 females) Same data. except. 10.iii.2010 (CETdeA); (2 males, 2 females) Same data. except. 7.iv.2010 (CETdeA); (2 males, 2 females) Same data. except. 5.v.2010 (CETdeA); (2 males, 2 females) Same data. except. 4.vi.2010 (CETdeA); (2 males, 2 females) Same data. except. 7.vii.2010 (CETdeA); (2 males, 2 females) Same data. except. 4.viii.2010 (CETdeA); (2 males, 2 females) Same data. except. 6.viii.2010 (CETdeA); (2 males, 2 females) Same data. except. 8.ix.2010 (CETdeA); (2 males, 2 females) Antioquia. Copacabana. La Clara. 06°22'07.1"N; 75°29'22.3"O. 13.xi.2010. V[an] S[omeren] R[ydon] mod[ificada]. 48h[oras]. Ramírez M., Durango Y., Areiza H Leg E. Amat & A. Pérez Det 2011 (CETdeA); (2 males, 2 females) Same data. except. 8.xii.2010 (CETdeA); (2 males, 2 females) Same data. except. 7.ii.2010 (CETdeA); (2 males, 2 females) Same data. except. 12.iii.2010 (CETdeA); (2 males, 2 females) Same data. except. 9.iv.2010 (CETdeA); (2 males, 2 females) Same data. except. 7.v.2010 (CETdeA); (2 males, 2 females) Same data. except. 2.vi.2010 (CETdeA); (2 males, 2 females) Same data. except. 9.vii.2010 (CETdeA); (2 males, 2 females) Same data. except. 8.ix.2010 (CETdeA); (2 males, 2 females) Same data. except. 6.x.2010 (CETdeA); (6 males, 6 females) Antioquia. Medellín. Cola del Zorro. 06°12'19.7"N;75°32'43.9"O. 1943m. 8. x.2010. V[an] S[omeren] R[ydon] mod[ificada]. 48h[oras]. Ramírez M., Durango Y., Areiza H Leg. E. Amat & A. Pérez Det 2011 (CETdeA); (1 male, 1 female) Same data. except. 10.iii.2010 (CETdeA); (1 male, 1 female) Same data. except. 12.iii.2010 (CETdeA); (2males, 2 females) Antioquia. Medellín. Pajarito. 06°17'10.7" N;75°36'43.7"O.1929m. 6. x.2010. Ramírez M., Durango Y., Areiza H Leg E. Amat & A. Pérez Det 2011 (CETdeA); (2 males; 2 females) Same data. except. 8.x.2010 (CETdeA); (2 females) Same data. except. 13.xi.2010 (CETdeA); (4 males, 2 females) Same data. except. 16.xi.2010 (CETdeA); (1 male) Same data. except. 8.xii.2010 (CETdeA); (6 males, 7 females) Same data. except. 10.xii.2010 (CETdeA); (2 males, 2 females) Same data. except. 10.iii.2010 (CETdeA); (2 male, 2 female) Same data. except. 7.iv.2010 (CETdeA); (2 male, 2 female) Same data. except. 7.vii.2010 (CETdeA); (3 males, 5 females) Chocó. Bahia Solano. Playa Huina. 6°16'18.12"N; 77°27'33.84"W. 53m. 25.ix.2013. V[an] S[omeren] R[ydon] mod[ificada]. 48h[oras]. Pérez-Pérez J, Gómez-Piñerez

LM y Quiroz M Leg. E. Amat & A. Pérez Det 2013 (CETdeA); (17 males) Magdalena. Res[erva]. Iguana Verde. 11°10'07.2" N; 74°10'37.4" O. 81m. 7.vii.2012. Valverde C. V[an] S[omeren] R[ydon] mod[ificada]. 48h[oras]. Leg. E. Amat Det 2015 (CETdeA); (1 female) Magdalena. Santa Marta. Cincinati. 11° 6'6.80"N; 74° 4'52.30"W 1433m. 2.iii.2013. V[an] S[omeren] R[ydon] mod[ificada]. 48h[oras]. Amat, E. Utria, G y Pérez L. Leg. E. Amat & A. Pérez Det 2013 (CETdeA); (2 females) Same data. except. 11° 6'6.94"N; 74° 4'52.69"W. 1427m (CETdeA); (1 male, 3 female) Magdalena. Santa Marta. Minca. 11°8'34.20" N; 74°6'31.50" O. 768m. 2.iii.2013. V[an] S[omeren] R[ydon] mod[ificada]. 48h[oras]. Amat, E. Utria, G y Pérez L. Leg. E. Amat & A. Pérez Det 2013 (CETdeA); (4 males, 4 females) Magdalena. Santa Marta. Bonda. 388m. 11°15'30.50"N; 74° 4'32.80"W. 3.iii.2013. Amat, E. Utria, G y Pérez L. V[an] S[omeren] R[ydon] mod[ificada]. 48h[oras]. Leg. E. Amat & A. Pérez Det 2013 (CETdeA); (1 male) Same data. except. 11°15'14.60" N; 74° 4'25.80"O. 390m. (CETdeA); (3 males) Same data. except. 11°14'9.80" N; 74° 4'17.00"O. 259m. (CETdeA); (22 male, 1 female) Meta. Puerto Gaitan. 04° 21’ 27.96" N; 71° 57’ 00.86" O. 196m. 10.vi.2013. V[an] S[omeren] R[ydon] mod[ificada]. 48h[oras]. J.M. Perilla Leg. E. Amat Det 2015 (CETdeA); (1 male, 2 females) Meta. San Martin. 03°31'37.3" N; 73°24'16.0" O. 249m. 6.vi.2013. V[an] S[omeren] R[ydon] mod[ificada]. 48h[oras]. Pérez-Pérez J & Gómez-Piñerez LM. Leg E. Amat & A. Pérez Det 2013 (CETdeA).**Ecuador** (9 males, 23 females) (1 female) Napo. Tena. -0.9988889; -77,83638889561m. 30-10-2015. M. Domínguez Leg. E. Amat Det 2016. QCAZ-I212268 (QCAZ-I); (1 male) Same data. except. QCAZ-I212272 (QCAZ-I); (1 female) Same data. except. QCAZ-I212266 (QCAZ-I); (1 male) Napo. Sarayacu. -0.6952778; -77,80027778. 1312m. 30-10-2015. M. Domínguez Leg. E. Amat Det 2016. QCAZ-I212267 (QCAZ-I); (1 female) Same data. except. QCAZ-I212271 (QCAZ-I); (1 female) Napo. Baeza. -0.4672222; -77,8925001. 1949m. 2015-01-11. M. Domínguez Leg. E. Amat Det 2016. QCAZ-I212269 (QCAZ-I); (1 male) Orellana. EC Yasuní. -0.6711111; -76,40277778. 194m. 2014-03-03. P. Padilla Leg. E. Amat Det 2016. QCAZ-I121821 (QCAZ-I); (1 female) Same data. except. 195m. 2014-01-03. M. Castro Leg. E. Amat Det 2016. QCAZ-I121830 (QCAZ-I); (1 male) Same data. except. 196m. M. Castro Leg. QCAZ-I121823 (QCAZ-I); (1 male) Same data. except. 197m. P. Padilla Leg. QCAZ-I121820 (QCAZ-I); (1 female) Same data. except. 198m. P. Padilla Leg. QCAZ-I121808 (QCAZ-I); (1 female) Same data. except. 199m. M. Castro Leg. QCAZ-I121831 (QCAZ-I);

(1 male) Same data. except. 200m. M. Castro Leg. QCAZ-I121825 (QCAZ-I); (1 female) Same data. except. 201m. D. Nieto Leg. QCAZ-I115003 (QCAZ-I); (1 female) Same data. except. 202m. Castro Leg. QCAZ-I121824 (QCAZ-I); (1 female) Pichincha. Puembo. -0.2027778; -78,32833333. 2592m. 29-07-2016. A. Torres Leg. E. Amat Det 2016 QCAZ-I212384 (QCAZ-I); (1 female) Same data. except. QCAZ-I212386 (QCAZ-I); (1 female) Pichincha. Amaguaña. -0.385; -78,48972222. 2618m. 29-07-2016. A. Torres Leg. E. Amat Det 2016. QCAZ-I212389 (QCAZ-I); (1 male) Same data. except. QCAZ-I212360 (QCAZ-I); (1 female) Same data. except. QCAZ-I212361 (QCAZ-I); (1 female) Pichincha. Cerro Ilaló. -0.2391667; -78,40666667. 2728m. 29-07-2016. A. Torres Leg. E. Amat Det 2016. QCAZ-I212396 (QCAZ-I); (1 female) Same data. except. QCAZ-I212397 (QCAZ-I); (1 female) Pichincha. Puembo. -0.2027778; -78,32833333. 2554m. 29-07-2016. A. Torres Leg. E. Amat Det 2016. QCAZ-I212385 (QCAZ-I); (7 female) Same data. except. QCAZ-I212388. QCAZ-I212392. QCAZ-I212393. QCAZ-I212394. QCAZ-I212395. QCAZ-I212398. QCAZ-I212359 (QCAZ-I); (2 male) Same data. except. QCAZ-I212390. QCAZ-I212391 (QCAZ-I).

***Lucilia ibis* Shannon, 1926**

(Figure 2, 16)

This is an endemic Andean species, distributed from Ecuador (2600m) to Argentina (700m) (Whitworth, 2014). In Peru, it was a common fly, hemisynanthropic and premontane (1200-2500m) exclusive of the eastern slope of the Andes. In the Northwest South America, it is exclusive of the southern Andean region (Figure 16) in the range of 1890-2900 (Figure 2). The detailed morphological description, including the male genitalia may be consulted in (Aubertin, 1933) together with the identification of adults in the recent revision of the genus by Whitworth (2014). The immature stages of Peruvian specimens were studied and described by Greenberg & Szyska (1984).

Specimens examined. (3 males, 13 females) **Ecuador** (3 males, 13 females). (1 female) Napo. Baeza. 0°28'2.00"S; 77°53'33.00"W. 1949m. 2015-11-01. Leg. M. Domínguez. 224473 (QCAZ-I); (1 male) same data except. 224474 (QCAZ-I); (1 female) same data except. 224475

(QCAZ-I); (1 female) same data except 224476 (QCAZ-I); (1 male) same data except. 224477 (QCAZ-I); (1 female) same data except. 224478 (QCAZ-I); (1 female) same data except. 224479 (QCAZ-I); (1 female) Pichincha. Amaguaña. 0°23'6.00"S; 78°29'23.00"W. 2618m. 2016-07-29. Leg. A. Torres. 224472 (QCAZ-I); (1 female) Pichincha. Cerro Ilaló. 0°14'21.19"S; 78°24'24.94"W. 2728m. 2016-07-29. Leg. A. Torres. 224469 (QCAZ-I); (1 female) Pichincha. Puembo. 0°12'10.00"S; 78°19'42.00"W. 2594m. 2016-07-29. Leg. A. Torres. 224465 (QCAZ-I); (1 female) same data except. 224466 (QCAZ-I); (1 female) Same data except. 224467 (QCAZ-I); (1 female) same data except. 224468 (QCAZ-I); (1 male) Pichincha. Quito. 2851m. 4° 41.834'N; 74°1.713'W2 016-07-16. Leg. A. Torres. 224464 (QCAZ-I); (1 female) same data except. 224470 (QCAZ-I); (1 female) same data except. 224471 (QCAZ-I).

Lucilia nitida **Whitworth, 2014**

(Figures 2, 14)

This is a South American species recently described, known in Brazil, Peru and Venezuela, where has a low lands and premontane (up to 900m) distribution (Whitworth, 2014). In the Northwest South America, it occurs in the Amazonian, Andean and Caribbean region (Figure 14) below 1240 m (Figure 2). The name it is derived for the shining condition of the presutural area of the thorax. the detailed morphological description together with the identification of adults may be consulted in the recent revision of the genus by Whitworth (2014). The bionomical aspects and the immature stages are unknown.

Specimens examined. (1 male, 2 females) **Ecuador** (1 male, 2 females) (1 female) Loja. P. N. Podocarpus. 4° 6'10.04"S; 78°56'56.11"W. 1027m. 2016-06-20; 2016-06-23. Leg. E. Moreno. Det. E. Amat 2015. TdeA10073 (QCAZ-I); (1 female) Napo. Narupa. 0°43'38.52"S; 77°46'22.14"O. 1240m. 2015-05-05; 2015-05-07. T[rampa] V[an] S[omeren] R[ydon]. Leg. E. Amat. Det. E. Amat 2015. TdeA-7040 (CETdeA); (1 male) Pichincha. Santo Domingo de los Tsáchilas. Otongachi. 0°18'51.32"S; 78°57'1.39"O. 889m. 2014-10-07. Leg. S. Aguirre Det. E. Amat 2015 (QCAZ-I).

***Lucilia pulverulenta* Whitworth, 2014**

(Figures 2, 14)

This is a South American species recently described, presents from Honduras to Ecuador, where it seems to be associated to low lands below 700m elevation (Whitworth, 2014) (Figure 2). As in the Northwest South America where it occurs in the Pacific and Andean region (Figure 14). The name it is derived for heavy dusting vestiture of the presutural area of the thorax. the detailed morphological description together with the identification of adults may be consulted in the recent revision of the genus by Whitworth (2014). The bionomical aspects and the immature stages are unknown.

Specimens examined (4 females) **Ecuador** (4 females) Tena. Via Muyuna. 0°55'56.92"S; 77°52'41.77"W. 690m. 2016-07-04. Leg. E. Amat y A. Pérez. Det. E. Amat 2016. TdeA10072 (CETdeA).

***Lucilia purpurascens* (Walker, 1836)**

(Figures 2, 16)

This is a Neotropical montane species distributed from Mexico to Argentina (Aubertin, 1933; James, 1970) in the South American Andes it is relatively common up to 2200m elevation (Whitworth, 2014). In Peru it was an uncommon fly, hemisynanthropic and present in the range 1300-1900m elevation (Baumgartner & Greenberg, 1985). In Colombia it have been recorded in the Andes at the central range up to 2800m (Wolff & Kosmann, 2016), although it was reported reaching the Páramo ecosystem as an uncommon fly near to the 3000m elevation (Amat, Perez-Hoyos & Alvarez in press). In the sierra Nevada de Santa Marta it also was a montane species, asynanthropic (S.I=-100), and closely related to the montane wet forest at an intermediate altitude range (1400-1500m) (Amat, Perez-Hoyos, & Rafael in press.).While in Venezuela it was recorded in the Merida Cordillera and the coastal range up to 2000 m (Velásquez *et al.*, 2017). In the Northwest South America, it occurs in the Andean, Caribbean and Tepuyan region (Figure 16) in the range of 110-2750m (Figure 2). A long history of confusion and misused on this name was clarify by Whitworth (2014), according to this author; it is one of the most distinctive species of *Lucilia* in the Neotropical region. The detailed morphological description, including the male and female genitalia together with the identification of adults may be consulted in his recent revision (Whitworth 2014). Aspects of their life cycles and the description of their immature stages were studied by Mariluis (1989); and the specimens from Colombia by Florez & Wolff (2009) (under *Lucilia peruviana*).

Specimens examined (52 males, 68 females) **Colombia** (41 males, 30 females) (3 males, 3 females) Antioquia. Medellín. Cola del Zorro. 06º12'19.7"N; 75º32'43.9"W. 1943m. 2010-03-10. T[rampa]12. T[rampa] V[an] S[omeren] R[ydon]. Leg. M.A. Ramírez, J. Durango, H. Areiza. Det. A. Pérez 2010 (CETdeA); (1 male, 1 female) Antioquia. Belmira. El morro. 6°38'27.43"N; 75°40'19.84"W. 3127m. 2012-01-05; 2012-01-09. T[rampa]13. T[rampa]12. T[rampa] V[an] S[omeren] R[ydon]. Leg. F. Álvarez & Grupo Insectario. A. Pérez 2014 (CETdA); (13 males, 8 females) Antioquia. Caldas. La Clara. 06º03'06.9"N; 75º37'19.2"W. 1840m. 2010-03-10. T[rampa]14. T[rampa] V[an] S[omeren] R[ydon]. Leg. M.A. Ramírez, C. Rave. Det. A. Pérez 2010 (CETdeA); (2 males, 1 female) Antioquia. Belmira. Malvazá. 6°38'28.34"N; 75°41'55.15"W. 2757m. 2012-08-06. T[rampa]09. T[rampa]14. T[rampa] V[an] S[omeren] R[ydon]. Leg. F. Álvarez & Grupo Insectario. Det A. Pérez 2014 (CETdeA); (1 male) Boyacá. Gachantivá. Vereda Saavedra de Roncancios. Reserva Natural de la Sociedad Civil Buenavista. 05°43'37.4"N; 73°31'59.1"W. 2616m. T[rampa]3. Leg. Miguel Torres & Johann Cardenas. Det. Torres Miguel 2016. 173055 (IAvH-E); (1 male) Same data except IAvH-E 173056 (IAvH-E); (1 male) Same data except IAvH-E 173057 (IAvH-E); (1 female) Same data except 05°43'40.5"N; 73°31'59.1"W. 2598m. 2016-03-01; 2016-03-04. T[rampa] 2. 173075 (IAvH-E); (1 female) Same data except IAvH-E 173076 (IAvH-E); (1 female) Same data except IAvH-E 173077 (IAvH-E); (5 males, 12 females) Magdalena. Santa Marta. Cincinati. 11°6'6.8"N; 74°4'52.3"W. 1433m. 2013-03-02. SMT01. Leg. E. Amat, G. Utria & L. Pérez. Det E. Amat A. Pérez 2013 (CETdeA); (1 male, 2 females) Same data except 11°6'6.94"N; 74°4'52.69"W. 1427m. SMT02 (CETdeA); (4 males) Same data except 11° 5'43.02"N; 74° 4'37.60"W. 1580m. SMT03 (CETdeA); (1 male) Magdalena. Santa Marta. El Ramo. 10°59'31.59"N; 73°42'43.80"W 2500m. Malaise tra[mpa] Leg. J. Cantillo. Det. E. Amat 2010. 110994 (IAVH-E); (1 male) Same data except IAVH-E

110995 (IAVH-E); (1 male) Nariño. Ricaurte. Centro Científico. 1,139757; -77,950622. 1700m. Jama. Leg. D. Arias. Det. E. Amat 2010. 111002 (IAVH-E); (1 male) Same data except 110996 (IAVH-E); (1 male) Same data except 110997 (IAVH-E); (1 male) Nariño. R[eserva] N[atural] La Planada. Via Hondon. 1,150477; -77,905706. 1930m. Malaise tra[mpa] Leg. G. Oliva. Det. E. Amat 2010. 111001 (IAVH-E); (1 male) Same data except 111000 (IAVH-E); (1 male) Same data except 110999 (IAVH-E); (1 male) Valle del Cauca. 2080m. Malaise tra[mpa] Leg. S. Sarria. Det E. Amat 2010. 110998 (IAVH-E). **Ecuador** (8 males, 34 females) (1 male) Cotopaxi. Las Pampas. 1500m. 2002-05-05. Leg. G. Caroti. Det. E. Amat 2015. QCAZ-I 212372 (QCAZ-I); (1 male) Imbabura. Los Cedros. -0.3052778 ; -78,77722222. 1180m. 2005-08-03. Leg. R. Cárdenas. Det. E. Amat 2015. QCAZ-I 212373 (QCAZ-I); (1 female) Same data except QCAZ-I 212378 (QCAZ-I); (1 female) Same data except -0.3311111; -78,78111111. 1880m. 2006-08-12. QCAZ-I 212374 (QCAZ-I); (1 female) Same data except QCAZ-I 212375 (QCAZ-I); (1 female) Same data except -0.3375; -78,79194444. 2220m. 2008-10-12. QCAZ-I 212376 (QCAZ-I); (1 female) Same data except QCAZ-I 212377 (QCAZ-I); (1 female) Loja. Loja. -4,0319444; -79,175. 2189m. 2015-07-17. Leg. A. García. Det. E. Amat 2015. QCAZ-I 212297 (QCAZ-I); (1 female) Morona-Santiago. Limon-Gualaceo. -3,247479; -78,681726. 2246m. 1984-09-02. DIP-0176. Leg. F.M. Ging. Det. E. Amat 2014. MECN 12129 (MECN); (1 male) Napo. Baeza. -0.4672222; -77,8925001. 1949m. 2015-10-31. Leg. M. Domínguez. Det. E. Amat 2015.QCAZ-I 212243 (QCAZ-I); (1 female) Same data except QCAZ-I 212274 (QCAZ-I); (1 female) Same data except QCAZ-I 212232 (QCAZ-I); (1 female) Same data except QCAZ-I 212233 (QCAZ-I); (1 female) Same data except 2015-11-1. QCAZ-I 212244 (QCAZ-I); (1 female) Same data except QCAZ-I 212270 (QCAZ-I); (1 male) Napo. Sarayacu. -0.6952778; -77,80027778. 1312m. 2015-10-28. Leg. M. Domínguez. Det. E. Amat 2015. QCAZ-I 212240 (QCAZ-I); (1 male) Same data except 2015-10-30. QCAZ-I 212242 (QCAZ-I); (1 female) Same data except QCAZ-I 212241(QCAZ-I); (1 female) Pichincha. Bellavista Ecient. -0.0108333; -78,68777778. 2287m. 2009-08-01. Leg. R. Cárdenas. Det. E. Amat 2015. QCAZ-I 212382 (QCAZ-I); (1 female) Pichincha. Sangolquí. Conocoto. -0.2916667; -78,47777778. 2538m. 2013-02-16. Leg. C. Castro. Det. E. Amat 2015. QCAZ-I 212383 (QCAZ-I); (1 female) Pichincha. Guajalito. -0.2166667; -78,75. 1800m. 2004-05-30. Leg. D. Paez. Det. E. Amat 2015. QCAZ-I 212363 (QCAZ-I); (1 female) Same data except QCAZ-I 212364 (QCAZ-I); (1 female)

Same data except QCAZ-I 212365 (QCAZ-I); (1 female) Same data except QCAZ-I 212366 (QCAZ-I); (1 female) Same data except QCAZ-I 212367 (QCAZ-I); (1 female) Same data except QCAZ-I 212368 (QCAZ-I); (1 female) Same data except QCAZ-I 212369 (QCAZ-I); (1 female) Same data except QCAZ-I 212370 (QCAZ-I); (1 female) Same data except QCAZ-I 212371 (QCAZ-I); (1 female) Pichincha. Nayón. -0.1666667; -78,41666667. 2397m. 2013-10-25. Leg. S. Aguirre. Det. E. Amat 2015. QCAZ-I 114999 (QCAZ-I); (1 female) Same data except QCAZ-I 115000 (QCAZ-I); (1 female) Same data except QCAZ-I 115001 (QCAZ-I); (1 female) Same data except QCAZ-I 115002 (QCAZ-I); (1 female) Pichincha. Quito. Parque Metropolitano. -0,1796; -78,471 2542m. 2015-05-15. Leg. W. Pruna. Det. E. Amat 2015. QCAZ-I 212245 (QCAZ-I); (1 female) Same data except QCAZ-I 212246 (QCAZ-I); (1 female) Same data except QCAZ-I 212247 (QCAZ-I); (1 female) Same data except QCAZ-I 212248 (QCAZ-I); (1 male) Same data except QCAZ-I 212249 (QCAZ-I); (1 male) Same data except QCAZ-I 212249 (QCAZ-I); (1 female) Zamora. Cantón El Pangui. -3,6249; -78,5871. 1376m. 2009-08-01. Leg. A. Argoti & T. Ghia. Det. E. Amat 2015. QCAZ-I 212381 (QCAZ-I); (1 male) Same data except 1413m. 2010-08-14. QCAZ-I 212379 (QCAZ-I); (1 female) Same data except QCAZ-I 212380 (QCAZ-I). **Venezuela** (3 males, 4 females) (2 males) Aragua. Villa de Cura. Est[acion]. Exp. Cataurito.10° 2'49.40"N; 67°19'13.36"W. 1100m. 1980-05-09. Det. E. Amat 2011 (MIZA); (1 female) Bolivar. Auyan-Tepui. 5° 51'N; 62° 33'W. 1700m. 1994-02-7; 1994-02-14. Leg. J. L. Garcia & A. Chacon. Det. E. Amat 2011 (MIZA); (1 female) Bolivar. Gran Sabana Roraima. 5°10'14.63"N; 60°51'27.81"W. 1800m. 1966-10-20. Leg. J. & B. Bechyne E. Osuna. Det. E. Amat 2011 (MIZA); (1 male, 1 female) Miranda. Altos de Pipe. 10°23'53.35"N; 66°59'6.77"W. 1600m. 2002-04-12. Leg. T. Pape Det. T. Pape 2002 (MIZA); (1 female) Tachira. Camp[o]. Hidroelectrico L. Ruiz. Pineda. La Trampita. 7°56'56.23"N; 71°43'31.47"W. 1150m. 1988-11-6; 1988-11-09. Leg. C.J. Rosales, J.De Marmeis & L. Joly, A. Chacon. Det. E. Amat 2011 (MIZA).

Lucilia rognesi **Whitworth, 2014**

(Figures 2, 15)

This is a neotropical species recently described. It occurs in Costa Rica, Honduras, Panama and Venezuela (up to 1300 m) (Whitworth, 2014). In the Northwest South America the only geographical record known is from Venezuela in the coastal range at 1183m (Whitworth, 2014) (Figure 15). We did not revised any specimens of *L. rognesi* in the entomological collections visited. the detailed morphological description together with the identification of adults may be consulted in the recent revision of the genus by Whitworth (2014). The bionomical aspects and the immature stages are unknown.

Lucilia sericata **(Meigen, 1826)**

(Figures 2, 13)

This is the common greenbottle fly, of almost worldwide distribution, from southern Canada to Argentina (James, 1970). However, it is most common in the temperate zone of the northern hemisphere, there apparently followed the man to others parts of the world including the tropical regions where its distribution is patchy (Greenberg, 1973). Likely to occurs in the larger cities in Central and South America (Whitworth, 2014). In Peru it was eusynanthropic, collected in both slopes of the Andes in the range 2050 to 3000m. It was dominant in some garbage dumps near Tarma (3000m). In Colombia it was reported closely related to urban environments at the east range of the Andes ranging 2543-2690 (Wolff & Kosmann, 2016); in Bogota (2600m) it is the most common urban fly, strongly eusynanthropic (Lopez-Cepeda & Fagua, 2015; Pinilla-Beltran *et al.*, 2012) and it was reported of remarkably forensic importance (Segura *et al.* 2009). Surprisingly it was not recorded in Venezuela (Velásquez *et al.*, 2017). In the Northwest South America it is exclusive of the temperate montane localities of the Andean region (Figure 13) in the range of 1530-2812m (Figure 2) according to the data retrieved it seems to be eusynanthropic, since all specimens were collected in places under urban influence. For its medical, forensic and veterinary importance, an extensive number of studies are available in literature; for further information of its basic biology, bionomical aspects and life history are see Greenberg (1973). The detailed morphological description may be consulted in Rognes (1991). The identification of neotropical adults may follow the key of Whitworth (2014). The life cycle and some bionomical aspects of Colombian populations were studied by Rueda *et al.* (2010), and their immature stages described by Florez & Wolff (2009).

Specimens examined. (39 males, 125 females) **Colombia** (14 males, 21 females) (1 female) Cundinamarca. Arbelaez. Vda. La Union. 1300m. A. Naranjo. Leg. (UNAB); (1 male) Cundinamarca. Bogotá. Universidad Distrital. 2550m. 01/Mar/2004. Reared in lab. Arango S. Leg. 111020 (IAVH-E); (5 males) Same data except. 111017. 111019. 111025. 111018. 111021 (IAVH-E); (1 female) Boyacá. Duitama. 5.8333; -73.0333. 2590m. C. Aranguren.Leg. (UNAB); (1 female) Same data except. A. Gordillo.Leg (UNAB); (1 male) Boyacá. Tunja. Universidad pedagógica y tecnológica. 5.6667; -73.3333. 2690m. Red entomologica sobre Cerdo. Yusseff & Daza Leg. UPTC F9612 (UPTC); (1 male) Same data except. UPTC F9610 (UPTC); (3 females) Same data except. UPTC F9613. UPTC F9611. UPTC F9609 (UPTC); (1 male) Boyacá. Villa de Leyva. En Jardin. 2200m. 27/Apr/2005. Manual. Reyes Z. Leg. 111023 (IAVH-E); (1 male) Same data except. 111022 (IAVH-E); (1 male) Same data except. Casco Urbano. 2200m. 20/Jun/2005. 111024 (IAVH-E); (1 female) Cundinamarca. 4.7333; -74.3500. W. Rabón. Leg. (UNAB); (1 male) Cundinamarca. 4.6058; -74.3069. A. Farias & O. Mateus Leg. (UNAB); (1 female) Cundinamarca. Facatativá. 2590m. A. Aranguren.Leg. (UNAB); (1 female) Same data except. Vda. San Rafael. M. L. Ruiz.Leg. (UNAB); (1 female) Cundinamarca. Funza. 4.7166; -74.2166 2540m. C. Forero.Leg. (UNAB); (1 male) Cundinamarca. Fusagasuga. 4.3422; -74.3616. 1721m. J. C. Duarte Leg. (UNAB); (1 female) Cundinamarca. Mosquera. 4.75; -74.3333. 2540m. López & Rico.Leg. (UNAB); (1 female) Cundinamarca. Pacho. 5.1333. -74.1666. 1790m. M Montalbán.Leg. (UNAB); (1 female) Cundinamarca. San Francisco. 4.9666; -74.2833. 1530m. Gaviria & Silva Leg. (UNAB); (1 female) Cundinamarca. Silvania. 4.4038; -74.3866. 1700m. W. Parra.Leg. (UNAB); (1 male) Cundinamarca. Subachoque. 4.9333; -74.1833. 2670m.C. Torres & H. Gualtero.Leg. (UNAB); (1 female) Cundinamarca. Tena. 4.6500; -74.4000. 1240m. W. Obando Leg (UNAB); (1 female) Cundinamarca. Usme. 4.4731; -74.1161. 2560m. F. Sánchez Leg. (UNAB); (1 female) Risaralda. Pereira. Finca Calamar. 4.816261; -75.674246.1460m. C. Forero & Rojas. Leg. (UNAB); (1 female) Risaralda. Santa Rosa de Cabal. 4.8666; -75.6333. 1680m. C. Varona. Leg. (UNAB); (1 female) Santander. La Belleza. Vda. La Playa. 5.8666; -73.9833. 2209m. Medina. Leg. (UNAB); (1 female) Tolima. Ibague. 4.4372; -75.2258. 1266m. V. Aguirre.Leg. (UNAB); (1 female) Valle del Cauca. Palmira. 3.5333; -76.2833. 1000m. L. Plata. Leg. (UNAB). **Ecuador** (25 males, 104 females) (1 female) Pichincha. Cantón Quito. Ciudad Quito. 2805m. 2016-06-16. 0°07´27.28´´S;

78°29´20.48´´O. V[an] S[omeren] R[ydon] mod[ificada]. 48h[oras]. QUT01. A. Torres Leg. A. Torres Det 2016 (QCAZ-I); (2 males, 4 females) Same data except. 0°11´27.07´´S; 78°30´01.16´´O. 2851m. QUT02 (QCAZ-I); (1 male, 2 female) Same data except. Parroquia Alangasi. Ilaló. 0°14´21.19´´S; 78°24´24.94´´O. 2728m. 2016-06-17. IBT02 (QCAZ-I); (16 males,16 females) Same data except. Parroquia de Amaguaña. 0°23´06.82´´S; 78°29´23.33´´O. 2618m. 2016-06-29. No es em el pueblo de Amaguaña. ART02. A. Pérez Det 2016 (QCAZ-I); (2 males, 45 females) Same data except. Parroquia de Puembo. Puembo. 0°11´58.91´´S; 78°19´59.97´´O. 2554m. PRT04. Faldas del León dormido. A. Torres Det. 2016 (QCAZ-I); (3 males, 12 females) Same data except. 0°12´10.46´´S; 78°19´42.28´´O. 2592m. SINÓNIMO PRT01. PRT03 (QCAZ-I); (3 females) Pichincha. DMQ. Bosque metropolitano del sur. 0°20'34.84"S; 78°31'08.77"O. 23/08/2016. BMS-BT05. V[an] S[omeren] R[ydon] mod[ificada]. 48h[oras]. A. Torres Leg. A. Torres Det. 2016 (QCAZ-I); (8 females) Same data except. Cashapamba. 0°21'24.17"S; 78°24'58.53"O. 2684m. C-R-T05 (QCAZ-I); (1 male, 9 females) Same data except. Quito. 0°12'38.61"S; 78°29'26.08"O. 2812m. 17/08/2016. QUT05 (QCAZ-I); (1 female) Pichincha. Machachi. 0,506945; -78,57722. 2900m. D. Navarrete Leg. E. Amat Det 2015 (QCAZ-I); (1 female) Pichincha. Palmeras. 1992-05-24. E. Pichilingue Leg. (QCAZ-I); (1 female) Pichincha. Nayon. -0,158707; -78,437237. 239m. 2013-10-13. S. Aguirre Leg. E. Amat Det 2014. QCAZ-I-114996 (QCAZ-I); (1 female) Same data except. -0,158707; -78,437237. 2397m. 2013-10-18. QCAZ-I-114997 (QCAZ-I).

Lucilia vulgata Whitworth, 2014

(Figures 2, 15)

This is a South American species recently described, widespread from Venezuela to Argentina and it has been collected up to 1690m (Figure 2) (Whitworth, 2014). In the Northwest South America, it was find in the Andean, Orinoquia and Tepuyan region (Figure 15). In spite to its widespread distribution, we only find one specimen at the foothills of the Andes in Ecuador, which meets all morphological diagnosis. The identification of adults may be consulted in the recent revision of the genus by Whitworth (2014). The bionomical aspects and the immature stages are unknown.

Specimens examined (1 female) **Ecuador** (1 female) Tena. Via Muyuna. 0°55'56.92"S; 77°52'41.77"W. 690m. 2016-07-04. Leg. E. Amat y A. Pérez. Det E. Amat 2016. TdeA10072 (CETdeA).

Toxotarsinae

Sarconesia Bigot, 1857

Sarconesia maurii Mariluis, 1981

(Figures 2, 17)

This is a high elevation species; endemic from the Andes of Ecuador at 3800m (Mariluis, 1981b) (Figure 17, 2), remarkably similar to *Sarconesia splendida* (Townsend, 1918). The type specimens of this species were originally identified as *S. splendida* and they were used to redescribe *S. splendida* sensu Mariluis (1978). However, two year later of the revision of Toxotarsinae by Dear (1979) when he revised the holotype of *S splendida* and described the male from Bolivian specimens, Mariluis considered that those specimens of *S. splendida* above mentioned belongs to a different species and described them as *S. maurii* (Mariluis, 1981b). *S. maurii* is only known for the type specimens, no additional records are known after its description. The type series was deposited in the collection of “ Instituto Entomológico San Miguel” presumably the current “Fundación Miguel Lillo” in San Miguél de Tucuman-Argentina. However, Mariluis (1981) cited that these series finally were under custody of the author, so no exist certainty of the final location of these type series. The morphological description is detailed in Mariluis (1978) and its validity discussed by Mariluis (1981). It is strongly recommended to review the type material to validate the correct status of this rare species; also more specimens from the type locality are desirable since the male genitalia is quite similar to *S. splendida* sensu Dear (1979) and its possible intraspecific variation that has not been documented. The bionomical aspects and the immature stages are unknown. We did not revised any specimens of *S. maurii* in the entomological collections visited.

***Sarconesia magellanica* (Le Guillou, 1842)**

(Figures 2, 19)

This is a high-elevation Andean species widely distributed from Colombia to Chile up to an elevation of 3250m (Dear, 1979). In Peru it was eusynanthropic, recorded as ranging from 1800 to 4000m on both Andean slopes (Baumgartner & Greenberg, 1985). In Colombia it is very common in the central and oriental ridges from above 1800 to 3000m (Amat, 2009), hemisynanthropic in the outskirts of Bogotá (Pinilla-Beltran *et al.*, 2012). It was reported of forensic importance in high elevations (Segura *et al.*, 2011). Recently it was recorded in the Páramo ecosystem where it was rare and not fully stablished (Amat, Perez-Hoyos & Alvarez in press); also recorded in the Sierra Nevada de Santa Marta above 2500m (Amat, Perez-Hoyos, & Rafael in press) and not yet recorded in Venezuela (Velásquez *et al.*, 2017). In the Northwest South America it is exclusive of the Andean Region (Figure 19) in the range of 2540 to 4047m (Figure 2). Some aspects of its biology and its life cycle parameters were studied by Pinilla *et al.* (2013). It has been study as a promissory species in larval therapy, specially for the effects of treating chronic wounds in vertebrates (Góngora *et al.*, 2015). The morphology including the male genitalia is detailed in (Dear, 1979).The identification of adults may follow the keys of Dear (1979) or Amat (2009). The immature stages of Peruvian specimens were studied by Greenberg & Szyska (1984) and those from Colombia by Florez & Wolff (2009).

Specimens examined (27 males; 32 females) **Colombia.** (12 males 24 females) (1 male) Boyacá. Villa de Leyva. S[antuario] F[auna] F[lora] Iguaque. Cabaña Chaina. 2600m. 5°40'28.47"N; 73°28'35.07"W. 2001.x.06. P. Reina Leg. Malaise trap E. Amat. det. 2009. IAVH111253 (IAvH-E); (1 male) same data except IAVH111254 (IAvH-E); (1 male) same data except IAVH111250 (IAvH-E); (1 male) same data except 2001-04-15 IAVH111248 (IAvH-E); (1 male) same data except 2001-04-15 IAVH111247 (IAvH-E); (1 male) same data except 2001-04-15 IAVH111246 (IAvH-E); (1 female) Magdalena. P[arque] N[acional] N[atural] Sierra Nevada de Santa Marta, El Ramo 10°48'7.59"N; 73°50'3.33"W. 2500m. 2000.xii.29. J. Cantillo Leg. E. Amat det. 2009. IAVH111251(IAvH-E); (1 female) Bogotá. Transv 66 N 145-45; 4.743197; -74.072573. 2540m. 2005.iv.03. J. Villa Leg. E. Amat det.

2009. IAVH111256 (IAvH-E); (1 female) same data except IAVH111252 (IAvH-E); (1 female) same data except IAVH111259 (IAvH-E); (1 female) same data except IAVH111255 (IAvH-E); (1 female) same data except IAVH111257 (IAvH-E); (1 female) Bogotá. Humedal de la Conejera. 4°45'43.59"N; 74° 6'13.00"W. 2560m. 2009-xii. E. Blanco Leg. M[uestra] 83 Muestreo Acueducto. E. Amat det. 2009. IAVH111258 (IAVH-E). (1 male) Nariño. Pasto. 2600m. 1°12'29.79"N; 77°15'21.08"W. D. Granja. E. Amat 2009 det. IAVH111260. (1 male) same data except IAVH111261 (IAVH-E); (1 female) same data except IAVH111262(IAVH-E); (3 females 1 male) Risaralda. Pereira. Ucumarí, La Pastora. 4°42'30.43"N;75°29'13.20"W. 2450m. C. Rojas & G. Ortiz Leg. Manual. E. Amat det. 2016 (UPTC); (6 females 2 males) Boyacá. Tunja. Puente Restrepo. 5°33'25.34"N;73°21'33.53"W. 2690m. 2013.xi.08. S. Gonzales & S. Daniel leg. Trampa de Caida. E. Amat det. 2016 (UPTC); (5 females 1 males) Boyacá. Tunja. Campus UPTC. 2800m. 5°33'8.63"N;73°21'30.03"W. 2012.ix.25. F. Molano leg. E. Amat det. 2016 (UPTC); (2 females) Antioquia Belmira Paramo de Belmira. 6°40'9.42"N;75°42'3.54"W. 2921m. 2013.x.22. F. Alvarez & Grupo Insecta Leg. V[an]. S[omeren]. R[ydon]. E. Amat & A. Perez det. 2015 (CETdA). **Ecuador** (15 males 8 females) (1 female) Pichincha. Quito. 0° 9'48.12"S; 78°30'1.15"W. 2800m. 1982.xii. J.J. Espinosa leg. E. Amat det. 2015. Dip-0865 - MECN-1 (MECN). (1 female) Pichincha. Quito. L. Aviles. 1978.xii. Calliphoridae-det A. Gentry. E. Amat det. 2015. Dip-0284 - MECN12267 (MECN); (1 female) Pichincha. Quito. 0°11'22"S;78°29'38"W. 2810m. 2005.iii.20. R. Zambrano Leg. E. Amat det. 2014. 12024 (QCAZ-I); (1 female) same data except 12026 (QCAZ-I); (1 female) same data except 12045 (QCAZ-I); (1 male) Azuay. Gualaceo. 2°53'60.00"S ;78°46'60.00"W. 2250m. 2002.xi.02. D. Morales leg. E. Amat det. 2014 (QCAZ-I); (1 male) Pichincha. Quito. Cumbayá. 0°12'59.55"S; 78°25'52.60"W. 2340m. 1995.i.15. Blarrea. E. Amat Leg. 2014 (QCAZ-I); (1 male) Pichincha. Pasochoa. 0°25'50.99"S;78°27'31.00"W. 3350m. 2012.v.24. G. Rivadeneira leg. E. Amat Leg. 2014 (QCAZ-I); (2 male) Ecuador Cotopaxi Latacunga 0°56'4.58"S; 78°37'30.87"W. 2768m. 2014.vii.30. W. Pruna Leg. W. Pruna det. 2014 (QCAZ-I); (1 male) same data except 2014.vii.27 (QCAZ-I); (3 males) same data except 2014.vii.20 (QCAZ-I); (2 males) Pichincha. Yanacocha. -0.121230;-78.579650. 3871m. 2014.v.28. E. Moreno Leg. E. Amat. det. 2014. (QCAZ-I); (3 males) Bolivar. San Miguel. 1°42'51.40"S; 79° 2'12.55"W. 2400m. 1991.xii.22. A. Barragan. E. Amat det. 2014 (QCAZ-I); (1 female) S[an]to. Domingo de los Tsachilas. 0°15'58.41"S; 78°45'15.68"W 2550m. 2012.iv.01.E. Calvache Leg. E. Amat det. 2014 (QCAZ-I); (1 male) Tungurahua. Ambato. 2575m. 1°14'12.00"S; 78°37'21.00"W. 2009. v.09. C. Acosta leg. E. Amat det. 2014 (QCAZ-I); (1 female) Pichincha. Sangolqui. 0°19'39.00"S; 78°26'6.00"W. 2600m. 2001.v.23. I. Alarcon Leg. E. Amat det. 2014 (QCAZ-I); (1 female) Pichincha. Sangolqui. 1992.vi.02. N. Acosta Leg. E. Amat det. 2014 (QCAZ-I).

Sarconesia roraima **(Townsend, 1935)**

(Figures 2, 17)

This is a South American montane species known from Venezuela to Chile up to an elevation of 3250m (Dear, 1979). In Venezuela it was reported in the montane tepuis, Merida Cordillera and the coastal range at 1900-2700m elevation (Velásquez *et al.*, 2017). In Colombia have been reported in the central and the oriental ridge in the range of 1900-2592m altitude (Wolff & Kosmann, 2016). It was reported as asynanthropic in the surrounding montane areas of Bogotá, Colombia (Pinilla-Beltran *et al.*, 2012). Recently it was collected in the Páramo ecosystem above 3127m, where it was asynanthropic (S.I=-31) (Amat, Perez-Hoyos & Alvarez in press), also in the Sierra Nevada de Santa Marta in the range 2100-2800. Surprisingly I was not found in Peru by Baumgartner & Greenberg (1985). In the Northwest South America, it occurs in the Andean, Caribbean and Tepuyan region (Figure 17), in the range of 1900-3127 (Figure 2). Little is known about its bionomical aspects and life history. This is a very distinctive species. Easy to recognize by their haired eyes, character not common in blow flies. The morphology including the male genitalia is detailed in (Dear, 1979), the identification of adult may follow the keys of (Dear, 1979) or (Amat, *et al.*, 2008). The immature stages are unknown.

Specimens examined. (54 males, 67 females) **Colombia** (48 males, 55 females): (2 males, 1 females) Antioquia. Belmira. Alto del Rio. 6°40'9.42"N; 75°42'3.54"W. 2921m. 2012.xii.15-20. F. Alvarez & Grupo Insectario Leg. VSR T[rap]04. E. Amat & A, Perez det. 2014 (CETdeA); (4 males, 3 females) same data except V[an]S[omeren]R[ydon] T[rap] 12 (CETdeA); (3 males, 4 females) same data except 2013-10-22. T[rap] 06 (CETdeA); (5 males, 7 females) same data except 2013-10-22. T[rap] 13 (CETdeA); (11 females)

Antioquia. Belmira. El índio. 6°37'58.82"N; 75°41'22.91"W. 2700m. 2013.x.22 F. Alvarez & Grupo Insectario Leg. V[an] S[omeren] R[ydon] T[rap] 04. E. Amat & A, Perez det. 2014 (CETdeA); (6 males, 3 females) same data except 2013.x.23. S[omeren] R[ydon] T[rap] 06. (CETdeA); (4 males 7 females) same data except 2013.ii.02. S[omeren] R[ydon] T[rap] 07. (CETdeA); (2 males 2 females) Antioquia. Belmira. El morro. 6°38'27.43"N; 75°40'19.84"W. 3127m. 2013.ii.13. F. Alvarez & Grupo Insectario Leg. V[an] S[omeren] R[ydon] T[rap] 03. E. Amat & A. Perez det. 2014 (CETdeA); (3 females) same data except T[rap] 07. (CETdeA); (6 males) same data except T[rap] 12. (CETdeA); (2 males, 2 females) same data except 5-9.i.2012. T[rap] 02. (CETdeA); (1 male 1 female) same data except. T[rap] 13. (CETdeA); (2 males 1 female) Antioquia. Belmira. Malvazá. 6°38'28.34"N; 75°41'55.15"W. 2757m. 2012.vii.08. F. Alvarez & Grupo Insectario Leg. V[an] S[omeren] R[ydon] T[rap] 09. E. Amat & A. Perez det. 2014 (CETdeA); (4 males, 2 females) same data except 2013.xi.02. T[rap] 11. (CETdeA); (1 male 2 females) Antioquia. Belmira. Montañitas. 6°37'23.11"N; 75°38'52.02"W. 3088m. 2012.vi.19. F. Alvarez & Grupo Insectario Leg. V[an] S[omeren] R[ydon] T[rap] 04. E. Amat & A. Perez det. 2014 (CETdeA); (1 female) same data except T[rap] 06. (CETdeA); (3 males) same data except T[rap] 03. (CETdeA); (1 male) same data except T[rap] 12. (CETdeA); (1 male 1 female) Antioquia. Belmira. Montañitas 2. 6°36'49.55"N; 75°39'20.65"W. 2956m. 2012.x.04. F. Alvarez & Grupo Insectario Leg. V[an] S[omeren] R[ydon] T[rap] 07. E. Amat & A. Perez det. 2014 (CETdeA); (1 male) same data except T[rap] 08. (CETdeA); (2 females) Antioquia. Belmira. Quebradona. 6°38'9.93"N; 75°39'48.58"W. 2900m. 2014. i.04. F. Alvarez & Grupo Insectario Leg. V[an] S[omeren] R[ydon] T[rap] 01. E. Amat & A. Perez det. 2014 (CETdeA); (1 female) same data except 2014.i.09. T[rap] 01. (CETdeA). **Ecuador** (7 males 10 females): (6 males, 10 females) Napo. Cosanga. Estación Biológica Yanayacu. 0°35'40.74"S; 77°53'36.43"W. 2275m. 2-4.iv.2015. A. Plant, J. Camara, E. Amat Leg. Malaise_Trap#2. E. Amat det. 2016 (QCAZ-I); (1 male) Pichincha. Quito. Cerro Ilaló. 0°15'45.72"S; 78°26'8.02"W. 2590m. vii.2016. A. Torres Leg. V[an] S[omeren] R[ydon] T[rap]. E. Amat & A, Perez det. 2016 (QCAZ-I). **Venezuela** (2 males 1 female) Vargas P[arque] N[acional] Pico Codazzi. Jenjibrillar. Geremba. 2300m. (MIZA).

Sarconesia splendida (Townsend, 1918)

(Figures 2, 18)

This is a high elevation Andean species known from Bolivia, Ecuador, and Peru; up to 4100m altitude (Dear, 1979). In Peru it was hemisynanthropic (S.I= +11), a dominant fly in the range of 3800m; it was collected regularly above 3250m (Baumgartner & Greenberg, 1985). In Colombia it was recorded in the eastern ridge of the Andes in the range of 2500-3500m altitude (Amat, 2009), not known in Venezuela. In the Northwest South America it was endemic of the Andean region; in Colombia and Ecuador (Figure 18), collected at high elevations ranging the 2540-4047m altitude (Figure 2). Their bionomical aspects are little known. For a detailed morphological description and for identification of the adults see Dear (1979). The immatures stages were described and studied by Greenberg & Szyska (1984).

Specimens examined (27 females) **Colombia.** (9 females) (1 female) Bogotá D.C, Humedal de la Conejera M[uestra] 83 Muestreo Acueducto. E. Blanco Leg. E. Amat det 2009 (IAvH); (4 females) Bogotá. Transv 66 N 145-45 2540m Colecta Manual 3.iv.2005 J. Villa Leg. E. Amat det 2009 (IAvH); (1 female) Cundinamarca, P[arque] N[acional] N[atural] Sumapaz. Bocatoma. Cerro el zapato 4º14'N; 74º12'W. 3560m. Pantrap. 6-7.xi.2002 A. Patiño, H. Ángel y D. Arias Leg. E. Amat det 2009 (IAVH); (3 females) same data except Malaise. 2-17.i.2003. A. Patiño Leg. (IAVH); **Ecuador.** (18 females) Napo, Páramo de Antisana, S0°27'34.3 W78°09'7", 4047m, 2016.vii.08, E[milia]. Moreno Leg. Pitfall. E. Amat det. 2016. 222012QCAZ to, 222029QCAZ. (QCAZ-I).

DISCUSSION

Although the checklist included 33 species, four of them were exclusively based in the literature (discussed below); The richness found here (28 spp) is equivalent to 40% of the Neotropical fauna of Calliphoridae *s.s*. reported by Kosmann *et al.* (2013). Based on this approach, we considered that the Northwest South America region as proposed here; is a remarkable hotspot for blow fly fauna diversification, specially the Andean region not only by its richness (27 spp) but for the greater number of exclusives (2) and endemic species (7).

A considerable number of specimens belonging to *Hemilucilia*, *Lucilia* and *Paralucilia* genera were not included in this study since their identification was not reliable. The taxonomic keys of Dear (1985) and Peris & Mariluis (1989) for *Hemilucilia* species, and the the taxonomic keys of Dear (1985) and Mello (1996) for *Paralucilia* species are problematic in the order to identify the same species; the combined of diagnostics characters proposed were ambiguous since each specialist suggested a set of features that unfortunately did not fit in the same species identity. We ensured that the specimens reviewed and identified here, belonging to these genera were reliable identified, since some of them were included in a parallel barcode study for their molecular identification. This allowed us to recognize some intraspecific characters and their morphological variations to identify the taxa; the detailed discussion on the variation of these characters can be consulted in (Amat *et al* in press). In spite of the recent revision of the Neotropical species of the genus *Lucilia* (Whitworth 2014), the identification process was extremely a hard task. Accordingly, a considerable large quantity of specimens were not identified; furthermore it is probably that a considerable number of new species remain to be described, especially those coming from remote places (Whitworth comm. pers.), one new species of *Lucilia* was detected in the Amazonian region; where a considerable larger number of new species are expected.

In the last three years, the publication of the checklists of blow flies from Colombia (Wolff & Kosmann, 2016), from Northwest Brazil (E. Amat *et al.*, 2016), from Ecuador (Salazar & Donoso, 2015) and from Venezuela (Velásquez *et al.*, 2017) optimally covered the current composition of the blow fly fauna from Northwest South America, proof of this was that no new records were reported in this study. However, we doubt the real existence of some taxa in the area of study; thus we discard the current occurrence of *C. rufifacies* and *C. melloi* two of the six species exclusive cited from the literature (see discussion below). Since the rest of the species not retrieved in this study, may be explained due to unidentified reasons including: the sampling effort bias, absence of sampling localities within their distribution area, the use of ineffective sampling methods, or due to their intrinsic biological heterogeneity such as their life history, rarity, population dynamics or local extinction phenomes, among others.

In the last two decades, *C. rufifacies* one of the introduced species into the New World was reported in the continental area of Northwest South America based in five geographical records; the first was in Colombia by Barreto *et al.* (2002), then in Ecuador by Tantawi & Sinclair (2013) and lately three in Venezuela by Thomas & Ferrer-Paris (2015). Although we had no chance to review these specimens we considered these identifications were erroneous, based on the morphological findings and the conclusions of Grella *et al.* (2015) about the invalids records of *C. rufifacies* in Brazil and moreover by the argue of the next four considerations: **1.** The high probability of misidentified *C. albiceps* specimens before Grella *et al.* (2015). since the coloration of the gena and the curvature of the wing vein M1+2 were unknown as diagnostic characters of interspecific variation among *C. albiceps* and *C. rufifacies.* In Ecuador Tantawi & Sinclair (2013) identified *C. rufifacies* based in the coloration of gena as yellow to orange; characters also present in the polymorphic *C. albiceps*. **2.** No specimens of *C. rufifacies* based in key of Grella *et al.* (2015) were found among the large number of polymorphic *C. albiceps* specimens revised in this study (3.119), including 70 localities in the five natural regions of Northwest South America. **3.** The confidence of the taxonomical identification made by the authors at that time. Since the records of *C. rufifacies* from Colombia were questioned by Amat (2009) and omitted lately by Wolff & Kosmann (2016). Recently, the records of Venezuela also were omitted by Velásquez *et al.* (2017) with no detailed argues. And finally; **4.** A recent inedited study of Amat *et al.* (2018) based in molecular data (minibarcodes) of the introduced *Chrysomya* species from the neotropical region, the study rejects the current occurrence of *C. rufifacies* in the Northwest South America corroborating the results of Grella *et al.* (2015). Thus *C. rufifacies* has not reach or is not well stablished in the continental South America yet. The case of *C. melloi* was detailed in the commented list (see above).

This study is by far the most comprehensive geographical dataset of neotropical blow flies, however, large areas from all proposed regions remained clearly undersampled. That is the case of the complete Tepuyan region which is the poorest area sampled; also extensive areas of the Amazonian region including the western Brazilian amazon connecting the Colombian Amazon, the northern of Peruvian Amazon and southern of Ecuadorian Amazon. In a similar state is the Colombo-Venezuelan savannah; the Colombian Caribbean plains along with the inter-Andean valleys, and finally the Pacific coastal regions of Colombia and Ecuador. Clearly, the pattern of spatial distribution of the geographical records is biased towards the proximity of cities (e.g. Bogotá, Caracas, Quito, Manaus, Medellín and Santa Marta) and their respective communication channels such as roads (e.g the Andean roads system connecting Venezuela, Colombia and Ecuador), tracks and rivers (e.g. along the black river in Brazil). The high values of diversity found in Ecuador and Colombia are explained by the existence of the Andean chain and their high elevation peaks (discuss below), it is remarkably the case of Colombia wich posses five natural regions of the six proposed. Based on the data gathered, it is possible to outline a preliminary pattern of species distribution and propose a categorization of the blow fly fauna based on their tendencies determinates by the occurrence in the elevation gradient, their biogeographic origin and their degree of association with urban ecosystems.

Zoogeographic considerations

Although the Tepuyan region is poorly sampled, contradictorily the two elevated areas proposed here, were the most and the least diverse respectively. The Andean region was the richest area for blow flies, this tendency is related to the presence of a remarkably variety of montane biomes, all depending of the climatic and topographical and edaphic conditions along the altitudinal gradient (Cleef *et al.*, 1984; Van der Hammen, 1984). Unlike the tepuyan area which has an abrupt ancient relief it is a kind of table-top mountain commonly known as “tepuis”. There are more than 120 tepuis, most of them in Venezuela and usually characterized as biological islands due to their shape and isolation from each other (Berry, Huber, & Holst, 1995). The rest of regions proposed corresponding to the low lands, plains, valleys and savannahs had an intermediate values of blow fly richness ranging the 9 to 17 species (Table 1). Unquestionably the presence of an altitudinal gradient in the Andean region promotes the diversity in blow flies as in many other groups of organisms to such scale that it had been considered as one of the most important biodiversity hotspot of the world (Russell A Mittermeier *et al.*, 2011; Myers *et al.*, 2000)

We considered three faunal categories accordingly the altitudinal range of occurrence, these are: Lowlands species, montane species and High elevation species (Table 3). Seventeen species were of low land distribution (below 1000m), these taxa have a wide distribution pattern in other Neotropical regions. Twenty seven species found in the range of 100 to 3000m were categorized as montane species. This aggrupation comprise twelve species typical of the low lands, this may reflect a relative ease pattern of colonize higher elevations in the altitudinal gradient. Finally eight species were assigned to the high elevation category (above 3000 m), these species were well stablished in the montane environments and they extended the altitudinal range to this extreme strip. The richness values here observed along the gradient corroborates the hypothesis of the highest values of diversity at intermediate altitudes in tropical environments (Rahbek, 1995) and it is in agreement with the diversity patterns of blow fly in the Peruvian Andes (Baumgartner & Greenberg, 1985).

All species, except *Lucilia rognesi* collected in the Venezuelan coastal range above the 1000m also occurs in the Andean region, this similarity of faunas allows us to think that the Venezuelan mountain coastal range could also belong to the Andean region in biogeographic terms, however it is priority a faunistic study of the blow fly fauna composition in the altitudinal gradient to validate if it belong to the same endemism area. In view of the enormous size of the Amazonian region in South America it is reasonable to consider changes in the blow fly composition fauna in areas away from those studied here, although the interfluvial region does not determine the composition of species (E. Amat *et al.*, 2016) it is essential to evaluate the composition of the blow fly fauna in others Amazonian areas especially those located southern of the Amazon river.

The current blow fly fauna of the northwest South America apparently have three evident biogeographical components. The first and the most widely distributed in the study area encompassing the tropical species. This group includes the Neotropical endemic *Blepharicnema*, *Chloroprocta*, *Hemilucilia*, *Paralucilia* and *Compsomyiops* genera. Noticeably, the eurythermal species *Lucilia eximia* and *Hemilucilia semidiaphana* belonging to the neotropical component are those taxa difficult to identify morphologically; it is possible that their allopatric populations reveal different biology and morphology. The second component is a temperate taxa of high montane distribution. This group includes the species of the Toxotarsinae subfamily, clearly phylogenetically closely related. This small component probably shared a common ancestor with circum-antartic or anphinotic distribution (Australia and South America) their geographic distribution extend their ranges northwest along the Andean belt reaching high elevations as they approach the equator line, some of them as far as Colombia and rarely to Venezuela (the case of *S. Roraima*), this is a common distribution pattern in several taxa of Diptera (Amorim, 2009). The last component comprise the widespread introduced taxa including *Calliphora vicina*, *Lucilia eximia* and *Lucilia sericata* and the invasive species of the *Chrysomya* genus which have became widely distributed as eurytherms in south America since their introduction in the seventies. Surprisingly, the dispersion routes of this biogeographic alien component are unknown. Some hypothesis of their intrusion were briefly described by Baumgartner and Greenberg (1984); but it is essential to understand the mechanism of introduction of the invasive species to track and evaluate the impact of these flies of medical, forensic and conservational importance insects in the presents global change scenarios. The biogeographical hypothesis for Neotropical blow flies must be drawn under the cladistics biogeography and the phylogeography frameworks in order to understand the Neotropical blow fly fauna origin and speciation processes across the altitudinal and latitudinal gradients. The detailed taxonomic revision of *Hemilucilia*, *Paralucilia* and *Compsomyiops* genera is extremely necessary, preferably including molecular data for the species delimitantion and the detection of cryptic species or a species complex. We recommend the study of spatial distribution models based in the geographical distribution data here offered, moreover including the anthropogenic influence and the synanthropic levels to contribute for the optimal applicability in the ecological, conservational and forensic fields.

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SUPPLEMENTARY FILES

File 1. Regionalization of the Northwest South America for blow fly (Diptera: Calliphoridae) fauna in shapefile format (.shp)
https://drive.google.com/file/d/0BwZ5kSltiF5CS3huTVJVQ1lxbGs/view?usp=sharing

File 2. Regionalization of the Northwest South America for blow fly (Diptera: Calliphoridae) fauna in polygon format (.kml) supported by Google Earth.
https://drive.google.com/file/d/0BwZ5kSltiF5CaVJySFBGMWxLUDg/view?usp=sharing

Files 2-34. Geographical localities records of blow flies (Diptera: Calliphoridae) for the Northwest South America in format (.kml) supported by Google Earth.

Calliphora nigribasis
https://drive.google.com/file/d/0BwZ5kSltiF5CTndXU0o1VDExeVE/view?usp=sharing

Calliphora vicina
https://drive.google.com/file/d/0BwZ5kSltiF5CQlRjLUIwNkpsQzg/view?usp=sharing

Chloroprocta idioidea
https://drive.google.com/file/d/0BwZ5kSltiF5CbTI0UGI2UTRFZ1E/view?usp=sharing

Chrysomya albiceps
https://drive.google.com/file/d/0BwZ5kSltiF5CUndYSUZGa3FOQzg/view?usp=sharing

Chrysomya megacephala
https://drive.google.com/file/d/0BwZ5kSltiF5CamNQR2REWVZVUVU/view?usp=sharing

Chrysomya putoria
https://drive.google.com/file/d/0BwZ5kSltiF5CQ3djekNDUS0tb0k/view?usp=sharing

Cochliomyia hominivorax
https://drive.google.com/file/d/0BwZ5kSltiF5CTks4V2lMRUtNREk/view?usp=sharing

Cochliomyia macellaria

https://drive.google.com/file/d/0BwZ5kSltiF5CTTExdHVtUkQ4ZUk/view?usp=sharing

Compsomyiops alvarengai

https://drive.google.com/file/d/0BwZ5kSltiF5CYnVKWlVtY3FJa1E/view?usp=sharing

Compsomyiops boliviana

https://drive.google.com/file/d/0BwZ5kSltiF5CZUNyZ1drZXFHb2c/view?usp=sharing

Compsomyiops verena

https://drive.google.com/file/d/0BwZ5kSltiF5CTVppTV8xLXU4cTA/view?usp=sharing

Hemilucilia benoisti

https://drive.google.com/file/d/0BwZ5kSltiF5CNHJleHRCWDc3NHM/view?usp=sharing

Hemilucilia melusina

https://drive.google.com/file/d/0BwZ5kSltiF5CeXBnaVRMQVNJeHc/view?usp=sharing

Hemilucilia segmentaria

https://drive.google.com/file/d/0BwZ5kSltiF5CR0NRZEdhZU8wNWM/view?usp=sharing

Hemilucilia semidiaphana

https://drive.google.com/file/d/0BwZ5kSltiF5CMVN0dkpsZ2l6eU0/view?usp=sharing

Paralucilia fulvinota

https://drive.google.com/file/d/0BwZ5kSltiF5CSktGZ3dEdUthYjQ/view?usp=sharing

Paralucilia paraensis

https://drive.google.com/file/d/0BwZ5kSltiF5Cc0FSejRSYS1udHM/view?usp=sharing

Blepharicnema splendens

https://drive.google.com/file/d/0BwZ5kSltiF5CWkpOZ2ZJQWFEdmM/view?usp=sharing

Lucilia albofusca

https://drive.google.com/file/d/0BwZ5kSltiF5CX0VDT1lIcXlSbVU/view?usp=sharing

Lucilia cuprina

https://drive.google.com/file/d/0BwZ5kSltiF5CZW83MVdNSVA0SWM/view?usp=sharing

Lucilia eximia

https://drive.google.com/file/d/0BwZ5kSltiF5CVVFLamFYc1hKbUU/view?usp=sharing

Lucilia ibis

https://drive.google.com/file/d/0BwZ5kSltiF5CZ1N2RVRZLWdQdk0/view?usp=sharing

Lucilia nitida

https://drive.google.com/file/d/0BwZ5kSltiF5CQVo0OGhUZVRSYjA/view?usp=sharing

Lucilia pulverulenta

https://drive.google.com/file/d/0BwZ5kSltiF5CMElRN09BSFBkdDQ/view?usp=sharing

Lucilia purpurascens

https://drive.google.com/file/d/0BwZ5kSltiF5Cc3FaZVFmVWhSTzA/view?usp=sharing

Lucilia rognesi

https://drive.google.com/file/d/0BwZ5kSltiF5CQW04SnRxWk5GbUE/view?usp=sharing

Lucilia sericata

https://drive.google.com/file/d/0BwZ5kSltiF5CRlNtVUgxeXN5QkE/view?usp=sharing

Lucilia vulgata

https://drive.google.com/file/d/0BwZ5kSltiF5CZ2FVYUZpcFBLd0E/view?usp=sharing

Sarconesia magellanica

https://drive.google.com/file/d/0BwZ5kSltiF5CS0huSzNZSnF1alE/view?usp=sharing

Sarconesia maurii

https://drive.google.com/file/d/0BwZ5kSltiF5CbkxkdlBwV0wtNTQ/view?usp=sharing

Sarconesia Roraima

https://drive.google.com/file/d/0BwZ5kSltiF5CRU1qNnRtREdXYlk/view?usp=sharing

Sarconesia splendida

https://drive.google.com/file/d/0BwZ5kSltiF5CT2t1RUhwNXBXT2s/view?usp=sharing

Table 1. Geographical and ecological information of the areas proposed in the regionalization of Northwest South America for blow flies**. Bra:** Brazil, **Col:** Colombia, **Ecu:** Ecuador, **Guy:** Guyana, **Pe:** Peru, **Ven:** Venezuela.*Elevated region.

Region	Area (Km^2)	%	Countries included	N° of geographical records	species richness	N° of endemic species
Amazonian	103.103	42.66	Bra, Col, Ecu, Pe, Ven	104	14	-
Andean*	39.277	16.25	Col, Ecu, Pen, Ven	375	30	9
Caribbean	25.772	10.68	Col,Ven	134	17	1
Orinoquia	37.101	15.35	Col, Ven	76	9	-
Pacific	11.331	4.68	Col, Pe	28	10	-
Tepuyan*	25.079	10.37	Bra, Guy, Ven	12	6	-
Northwest South America	241.663	99.99	Bra, Col, Ecu, Guy, Pe, Ven	729	32	-

Table 2. Checklist of the blow flies of Northwest South America by natural region, occurrence by country, number of specimens revised in this study and details of the selected records from literature. **A**: Asynanthropic; **E**: Eusynanthropic; **H**: Hemisynanthropic; **Col**: Colombia; **Ecu**: Ecuador; **NwBr**: Northwest Brazil; **NPer**: Northern Peru; **Ven**: Venezuela. *Introduced species; †not found in this study; ‡known only from the original description.

Subfamily	**Species**	**Synanthropy**	**Distribution by natural region**						**Distribution by country**	**N° of specimens examined**	**N° of geographical records**	**References (Selected records)**
			Amazonian	**Andean**	**Caribbean**	**Orinoquia**	**Pacific**	**Tepuyan**				
Calliphorinae	*Calliphora nigribasis* Macquart, 1851	H		X	X				Col, Ecu, Ven	30	24	Segura et al (2009); Martinez et al (2007); Whitworth (2012).
	Calliphora vicina Robineau-Desvoidy, 1830	E		X					Col, Ecu	35	13	-
Chrysomyiinae	*Chloroprocta idioidea* (Robineau-Desvoidy, 1830)	A	X	X	X	X	X		Col, Ecu, NwBr, Ven	4481	46	-
	**Chrysomya albiceps* (Wiedemann, 1830)	H - E	X	X	X	X	X		Col, Ecu, NwBr, Ven	3119	70	-
	**Chrysomya megacephala* (Fabricius, 1794)	E	X	X	X	X	X		Col, Ecu, NwBr, Ven	801	47	-
	**Chrysomya putoria* (Wiedemann, 1830)	E	X	X					Col, NwBr, Ven	888	25	Ramirez-Mora et al (2012); Velasquez et al (2017); Carvalho and Couri (1991).
	Cochliomyia hominivorax (Coquerel, 1858)	-	X	X	X		X		Col, Ecu,Ven	12	7	
	Cochliomyia macellaria (Fabricius, 1775)	E	X	X	X	X	X	X	Col, Ecu, NwBr, Ven	601	76	Amat (2009); Liria (2006); Ramos-Pastrana *et al.* (2014).
	†*Compsomyiops alvarengai* (Mello, 1968)	?		X					Ecu	0	1	Dear (1985)
	†*Compsomyiops boliviana* (Mello, 1968)	H		X					Ecu	0	7	Dear (1985; González-Mora *et al.* (1998).
	Compsomyiops verena (Walker, 1849)	A - H		X	X				Col, Ecu, Ven	593	52	-
	Hemilucilia benoisti Séguy, 1925	A	X	X	X	X			Col, Ecu, NwBr, Ven	6	9	Dear (1985); Carvalho & Couri (1991); Peris & Mariluis (1989)
	Hemilucilia melusina Dear, 1985	A		X					Col	1	5	Wolff and Kosmann (2016); Dear (1985).
	Hemilucilia segmentaria (Fabricius, 1805)	A	X	X	X		X	X	Col, Ecu, NwBr, Ven	114	49	Carvalho & Couri (1991)
	Hemilucilia semidiaphana (Rondani, 1850)	A	X	X	X	X	X		Col, Ecu, NwBr, Ven	1495	30	-
	Paralucilia fulvinota (Bigot, 1877)	A		X	X				Col, Ecu, NwBr, Ven	107	15	Dear (1985)
	Paralucilia paraensis (Mello, 1969)	H	X	X					Col, Ecu, NwBr, Ven	169	16	Mariluis *et al.* (1994).

Table 2. (Continuation) Checklist of the blow flies of Northwest South America by natural region, occurrence by country, number of specimens revised in this study and details of the selected records from literature. **A**: Asynanthropic; **E**: Eusynanthropic; **H**: Hemisynanthropic; **Col**: Colombia; **Ecu**: Ecuador; **NwBr**: Northwest Brazil; **NPer**: Northern Peru; **Ven**: Venezuela. *Introduced species; †not found in this study; ‡known only from the original description.

Subfamily	Species	Synanthropy	Distribution by natural region						Distribution by country	N° of specimens examined	N° of geographical records	References (Selected records)
			Amazonian	Andean	Caribbean	Orinoquia	Pacific	Tepuyan				
Luciliinae	*Blepharicnema splendens* Macquart, 1843	A		X	X				Col, Ecu, Ven	57	29	-
	Lucilia albofusca Whitworth, 2014	?	X				X	X	Col, Ecu, NwBr, Ven	51	13	Whitworth (2014)
	Lucilia cuprina (Wiedemann, 1830)	E	X	X	X	X			Col, Ecu, NPer, Ven	51	16	Whitworth (2014)
	Lucilia eximia (Wiedemann, 1819)	E	X	X	X	X	X		Col, Ecu, NwBr, Ven	366	27	Whitworth (2014); Velásquez *et al.* (2017)
	Lucilia ibis Shannon, 1926	H		X					Ecu, NPer	16	7	Whitworth (2014)
	Lucilia nitida Whitworth, 2014	?	X	X	X				Ecu, Nper, Ven	3	5	Whitworth (2014)
	Lucilia pulverulenta Whitworth, 2014	?		X			X		Col, Ecu	4	4	Whitworth (2014)
	Lucilia purpurascens (Walker, 1836)	A – H		X	X			X	Col, Ecu, Ven	120	31	-
	†*Lucilia rognesi* Whitworth, 2014	?			X				Ven	0	1	Whitworth (2014)
	Lucilia sericata (Meigen, 1826)	E		X					Col, Ecu	164	34	-
	Lucilia vulgata Whitworth, 2014	?		X		X		X	Col, Ecu, Ven	1	4	Whitworth (2014)
Toxotarsinae	†‡*Sarconesia maurii* Mariluis, 1981	?		X					Ecu	0	1	Mariluis (1981)
	Sarconesia magellanica (Le Guillou, 1842)	H – E		X					Col, Ecu	59	20	-
	Sarconesia roraima (Townsend, 1935)	A		X	X			X	Col, Ecu, Ven	122	39	Mello (1978); Dear (1979); Wolff & Kosmann (2016); Velásquez *et al.* (2017)
	Sarconesia splendida (Townsend, 1918)	H		X					Col, Ecu	27	6	Dear (1979).

Table 3. Tendencies of altitudinal categorization, synanthropy and biogeographical components of the blow fly fauna (Calliphoridae) in the North West South America. Origen of the faunistic component: * Tropical; **†** Temperate; **‡** Introduced. **?** Uncertain, no main human settlement above this elevation. The eurythermal species (0 - ≥200 m) are underline.

	Altitudinal category		
Synanthropy	**Lowlands (0-1000m)**	**Montane (1000-3000m)**	**High elevations (≥3000)**
Asynanthropic	*_Chloroprocta idioidea_ *_Hemilucilia benoisti_ *_Hemilucilia segmentaria_ *_Hemilucilia semidiaphana_ *_Paralucilia fulvinota_	*_Compsomyiops verena_ *_Hemilucilia melusina_ *_Hemilucilia segmentaria_ *_Hemilucilia semidiaphana_ *_Paralucilia fulvinota_ *_Lucilia purpurascens_ †_Sarconesia roraima_	*_Compsomyiops verena_ †_Sarconesia roraima_
Hemisynanthropic	*_Paralucilia paraensis_	*_Calliphora nigribasis_ *_Compsomyiops boliviana_ *_Compsomyiops verena_ *_Blepharicnema splendens_ *_Lucilia ibis_ *_Lucilia purpurascens_ †_Sarconesia magellanica_	*_Calliphora nigribasis_ *_Compsomyiops boliviana_ *_Compsomyiops verena_ †_Sarconesia magellanica_ _Sarconesia splendida_
Eusynanthropic	‡_Chrysomya albiceps_ ‡_Chrysomya megacephala_ ‡_Chrysomya putoria_ *_Cochliomyia macellaria_ ‡_Lucilia cuprina_ *_Lucilia eximia_	‡_Calliphora vicina_ ‡_Chrysomya albiceps_ ‡_Chrysomya megacephala_ ‡_Chrysomya putoria_ *_Cochliomyia macellaria_ ‡_Lucilia cuprina_ *_Lucilia eximia_ ‡_Lucilia sericata_	?
Insufficient data	*_Cochliomyia hominivorax_ _Lucilia albofusca_ _Lucilia pulverulenta_ _Lucilia vulgata_ _Lucilia nitida_	*_Cochliomyia hominivorax_ _Compsomyiops alvarengai_ _Lucilia nitida_ _Lucilia rognesi_ _Lucilia vulgata_	_Sarconesia maurii_

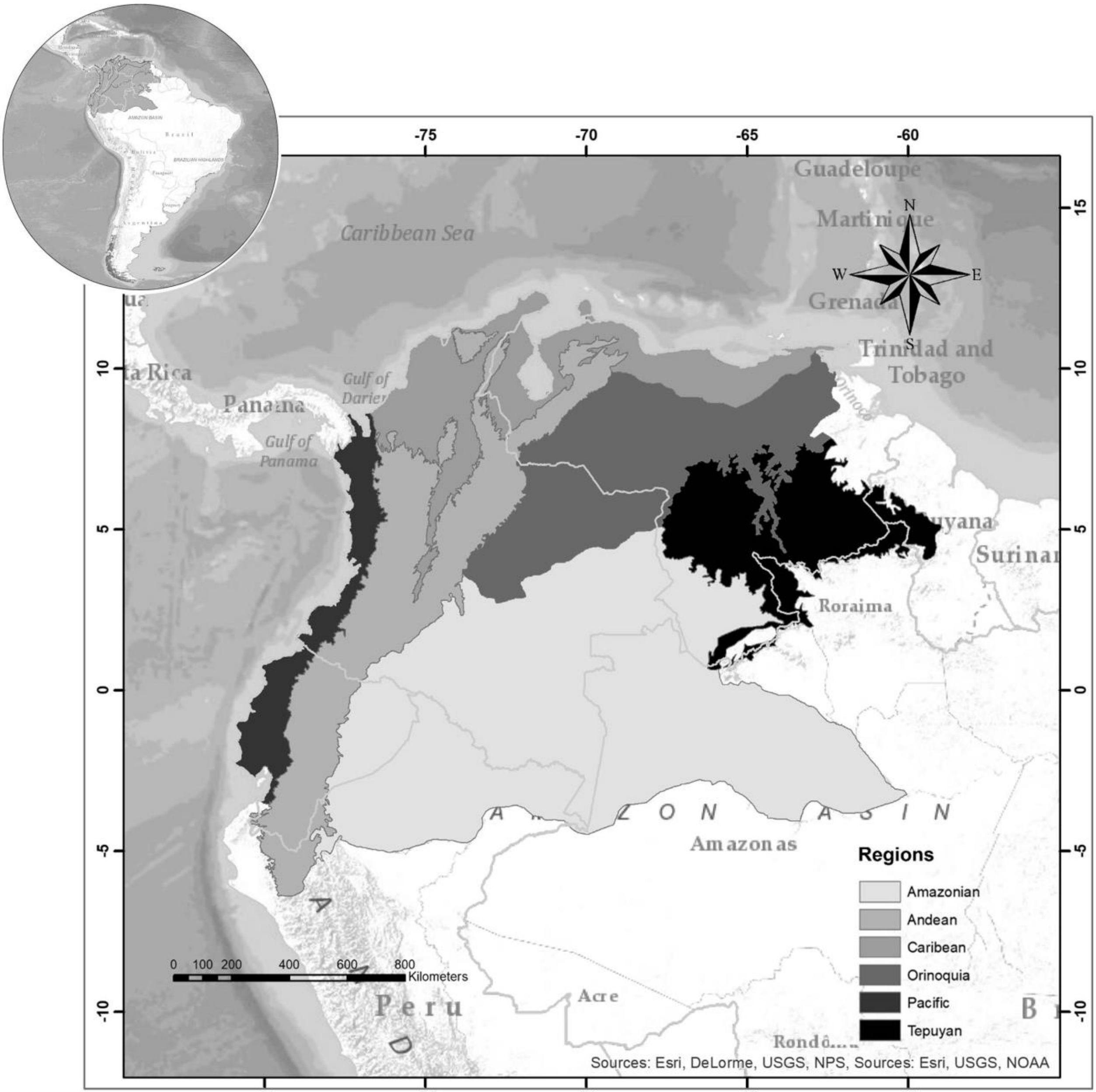


Figure 1. Map of Northwest South America showing the proposed regionalization for blow fly fauna (Diptera: Calliphoridae).

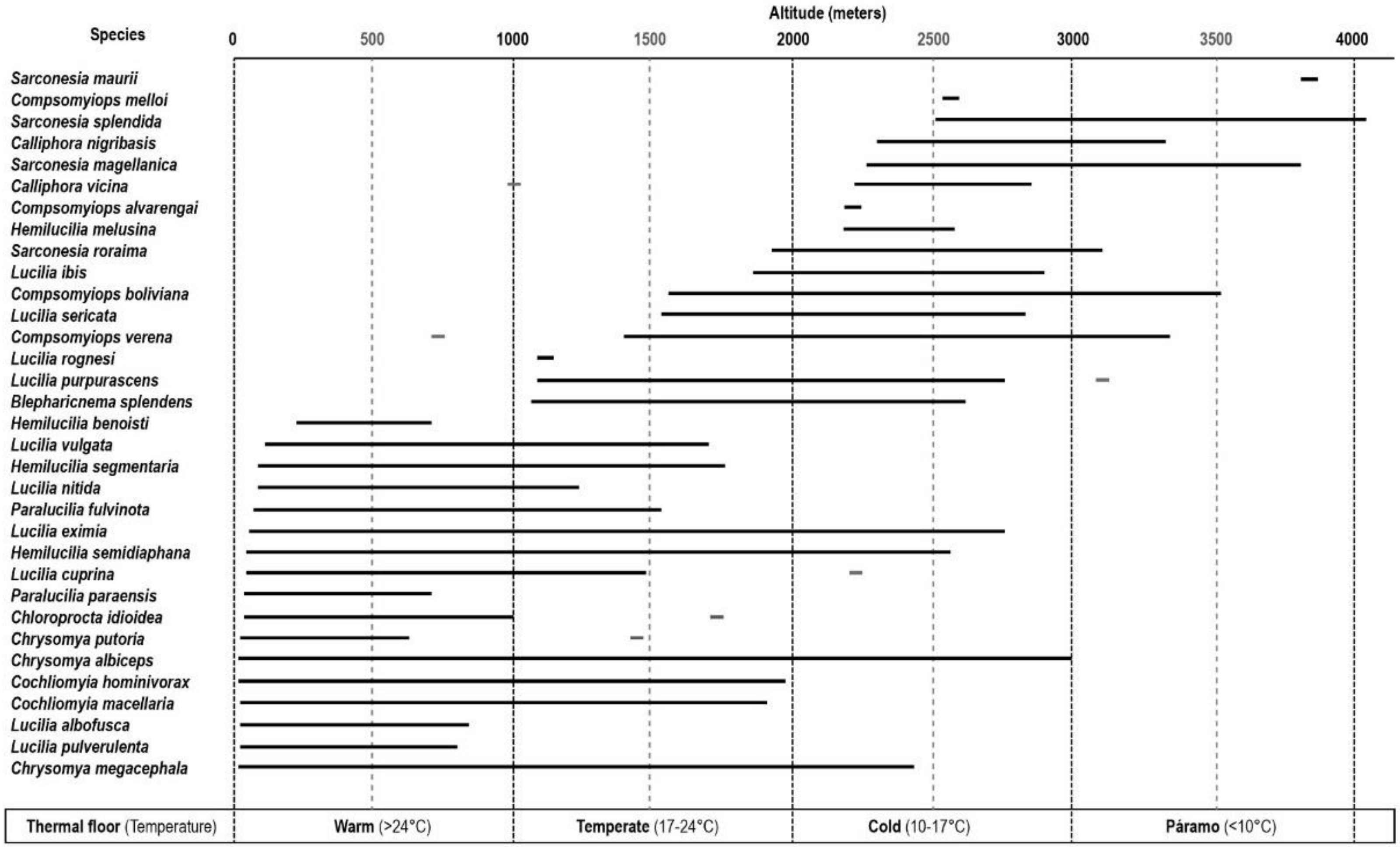


Figure 2. Altitudinal zonation of blow flies in Northwest South America

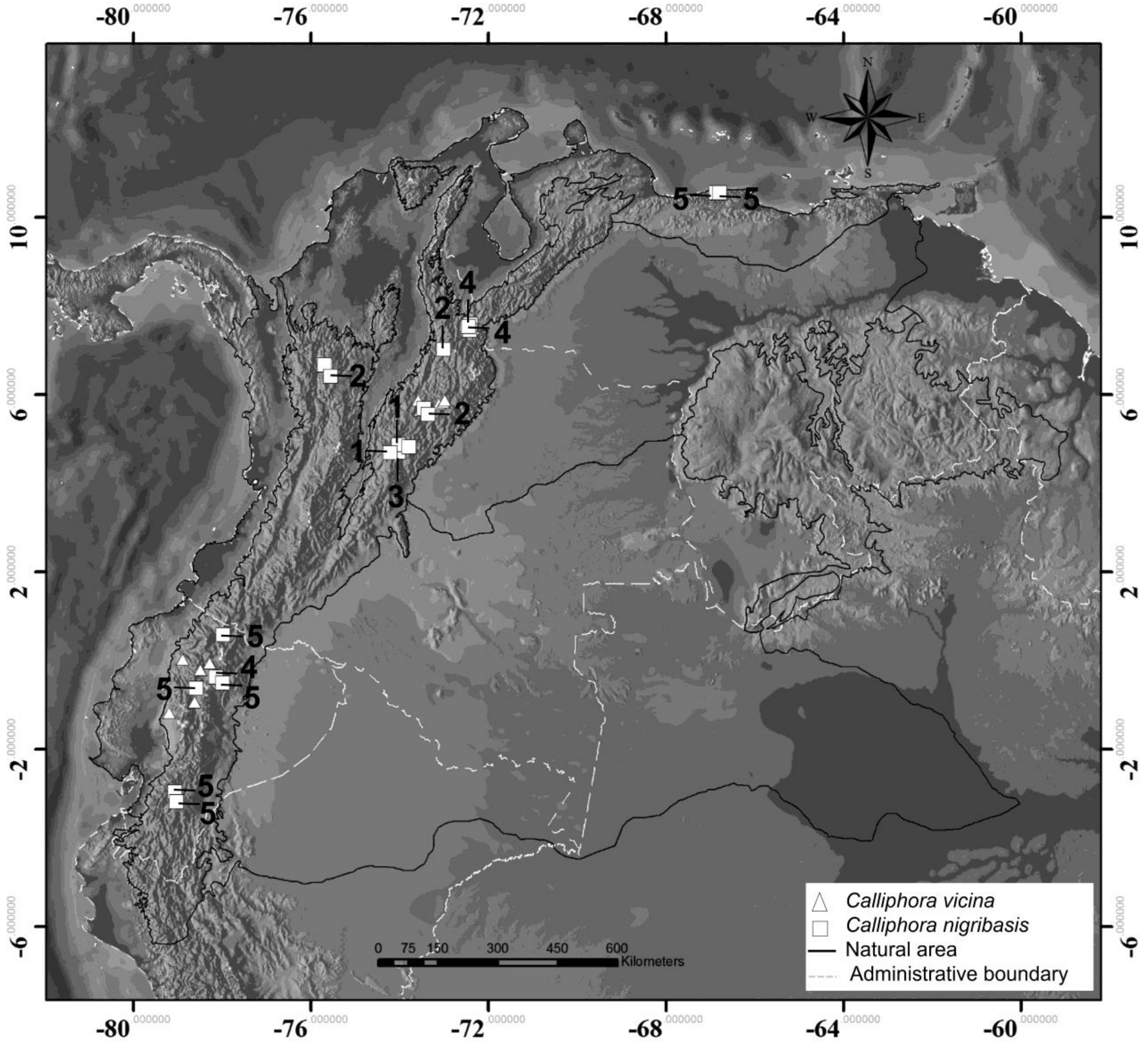


Figure 3. Map of the distribution localities for *Calliphora vicina* Robineau-Desvoidy, 1830 and *Calliphora nigribasis* Macquart, 1851 in the northwest South America. Records based in literature: **1.** Segura *et al* (2009); **2.** Wolff and Kosmann (2016); **3.** Martinez *et al* (2007); **4.** Amat *et al* in press; **5.** Whitworth (2012).

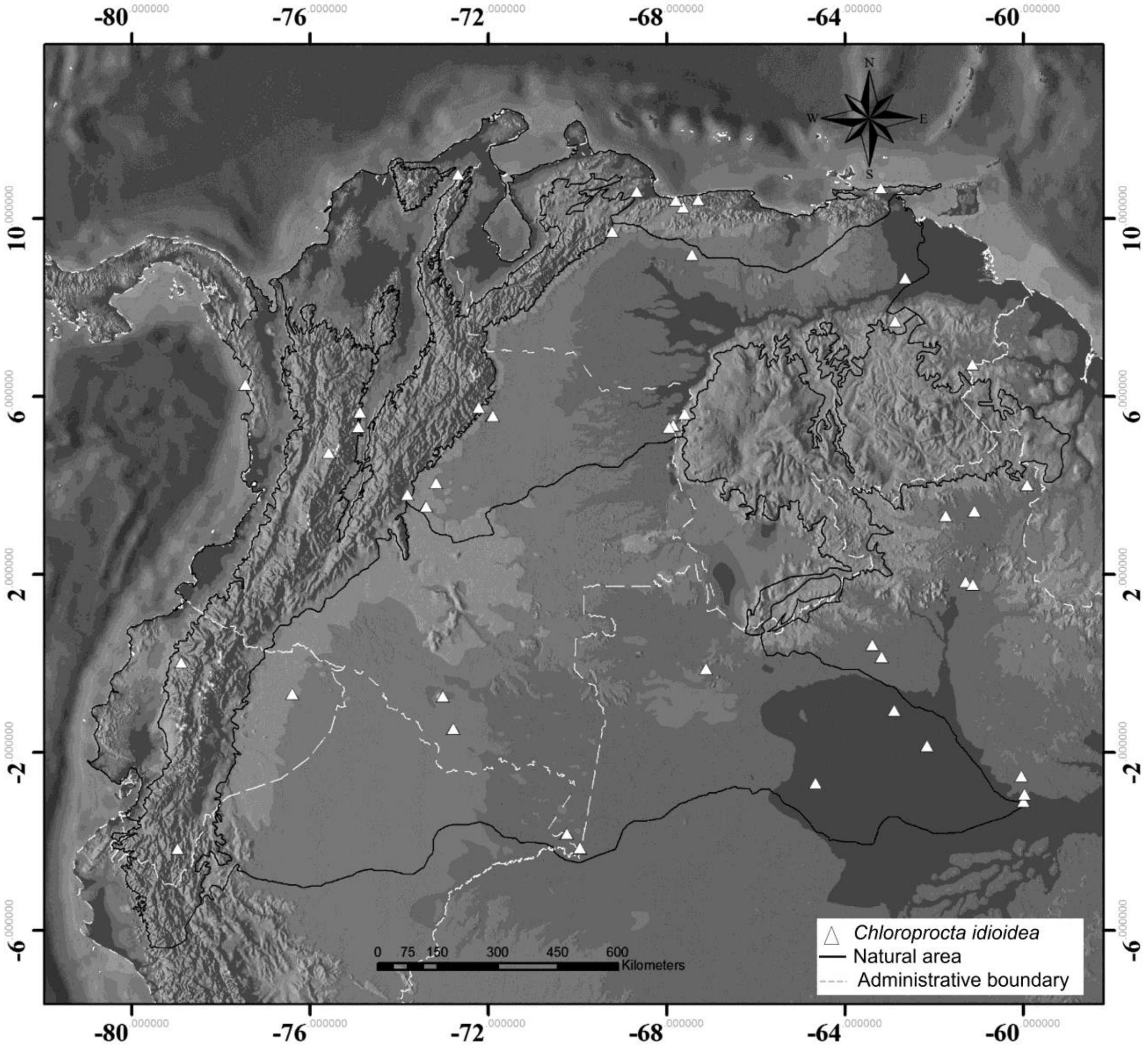


Figure 4. Map of the distribution localities for of *Chloroprocta idioidea* (Robineau-Desvoidy, 1830) in the northwest South America.

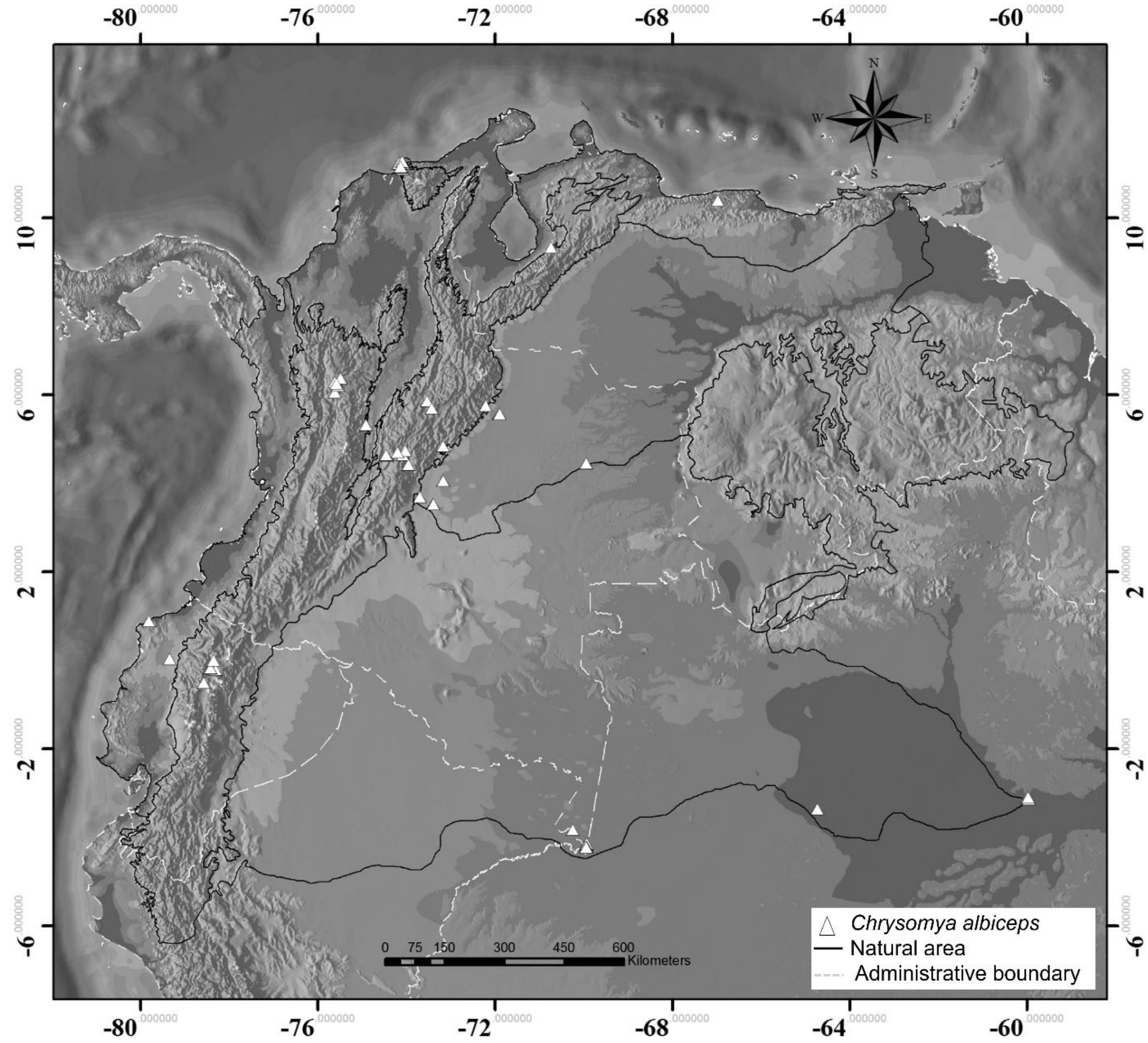


Figure 5. Map of the distribution localities for of *Chrysomya albiceps* (Wiedmannm, 1830) in the northwest South America.

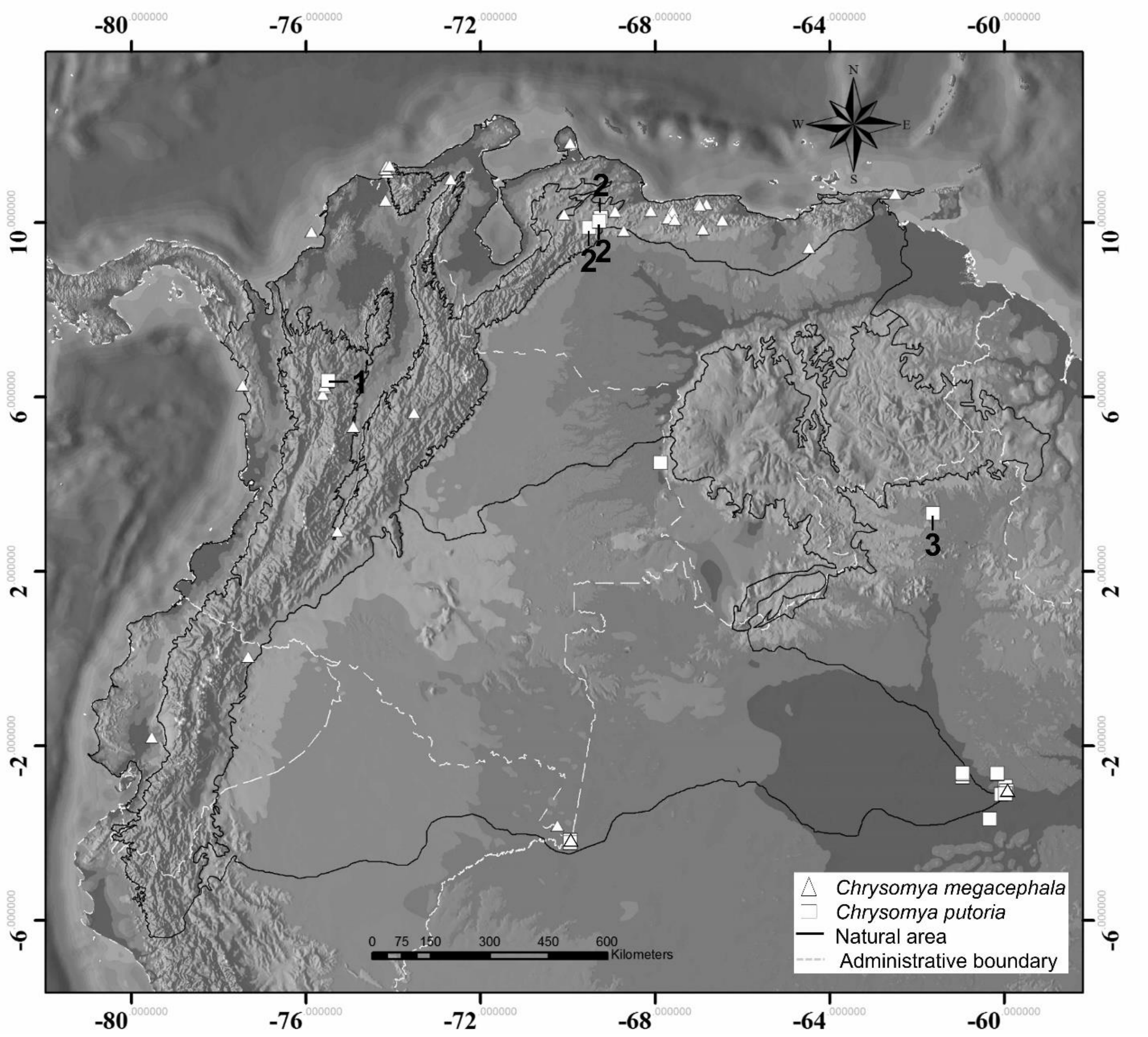


Figure 6. Map of the distribution localities for *Chrysomya megacephala* (Fabricius, 1794) and *Chrysomya putoria* (Wiedmannm, 1830) in the northwest South America. . Records based in literature: **1.** Ramirez-Mora *et al* (2012); **2.** Velasquez *et al* (2017); **3.** Carvalho and Couri (1991).

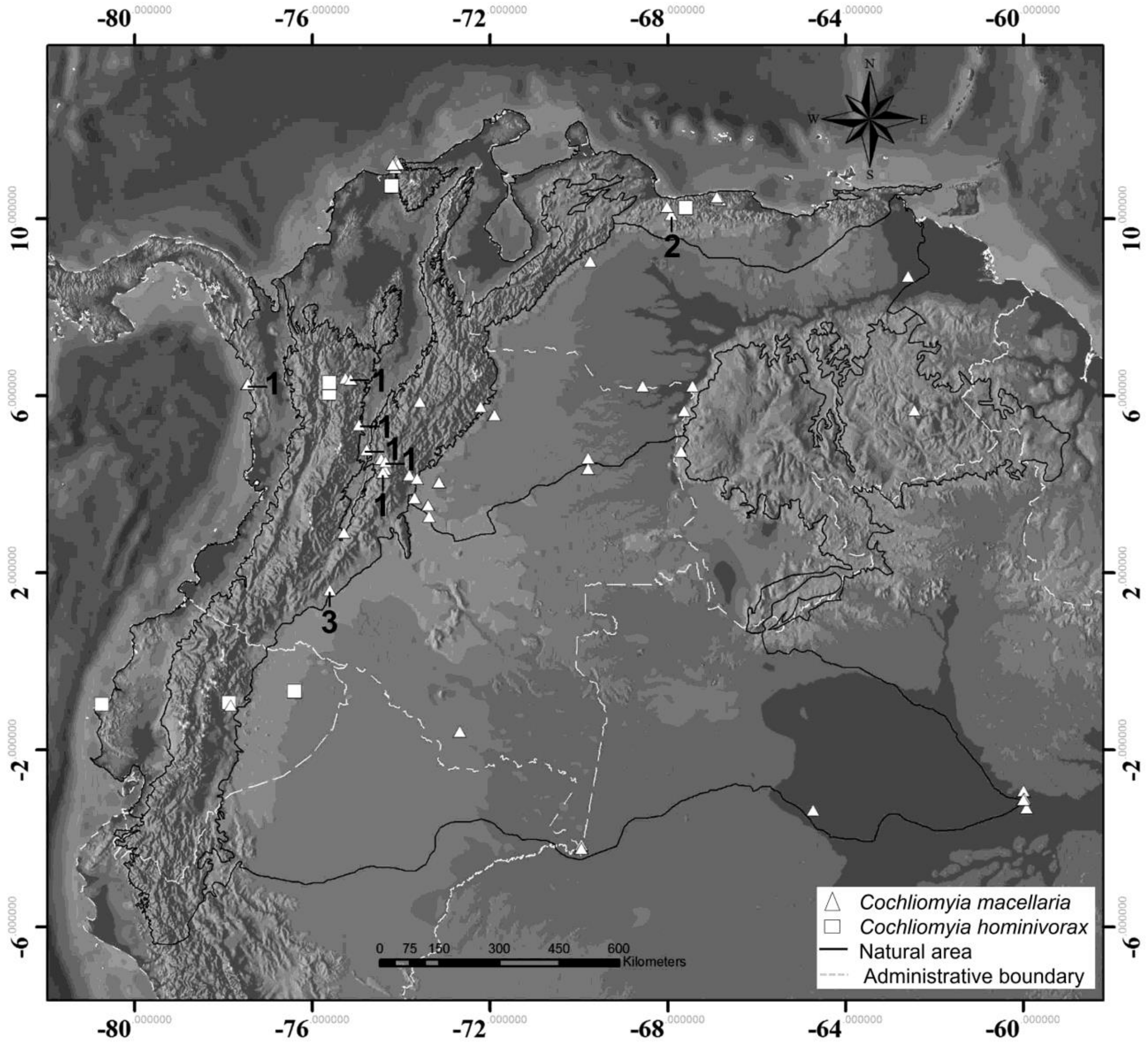


Figure 7. Map of the distribution localities for *Cochliomyia macellaria* (Fabricius, 1755) and *Cochliomyia hominivorax* (Coquerel, 1858) in the northwest South America. Records based in literature: **1.** Amat (2009); **2.** Liria (2006); **3.** Ramos-Pastrana *et al.* (2014).

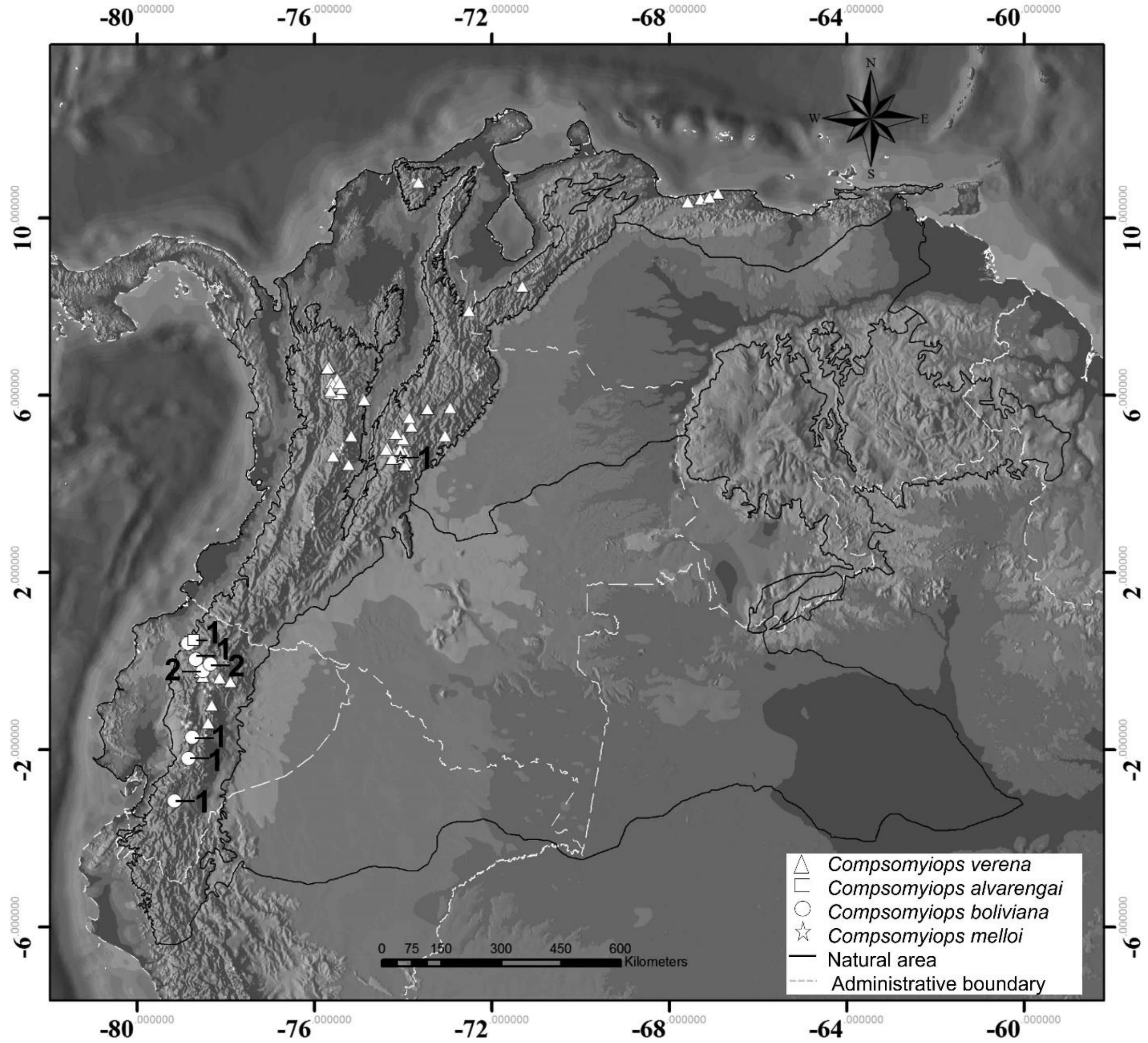


Figure 8. Map of the distribution localities for *Compsomyiops verena* (Walker, 1849), *Compsomyiops alvarengai* (Mello, 1968), *Compsomyiops boliviana* (Mello, 1968) and *Compsomyiops melloi* Dear, 1985 in the northwest South America. Records based in literature: **1.** Dear (1985) **2.** González-Mora *et al.* (1998).

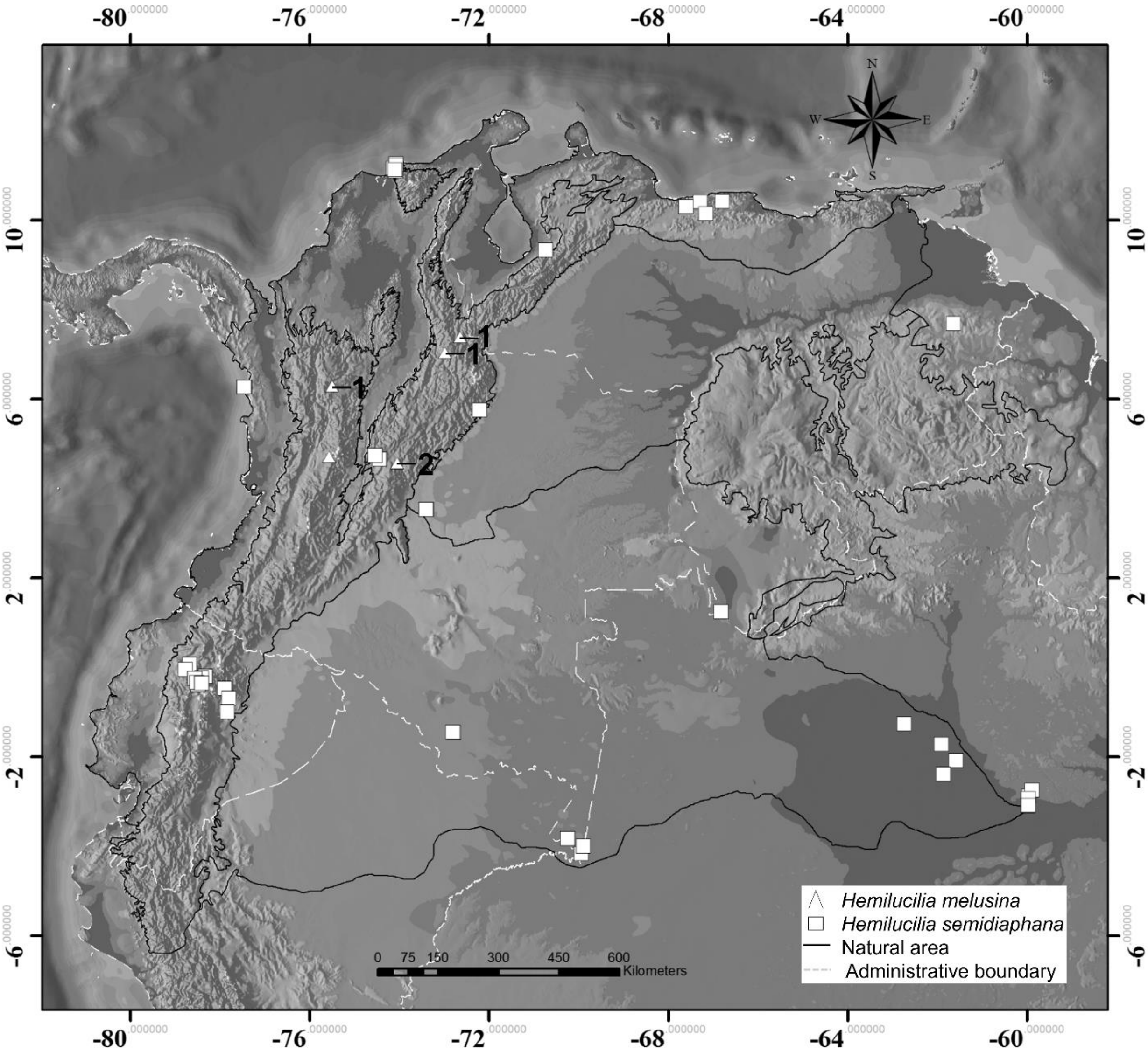


Figure 9. Map of the distribution localities for *Hemilucilia melusina* Dear, 1985 and *Hemilucilia semidiaphana* (Rondani, 1850) in the northwest South America. Records based in literature: **1.** Wolff and Kosmann (2016); **2.** Dear (1985).

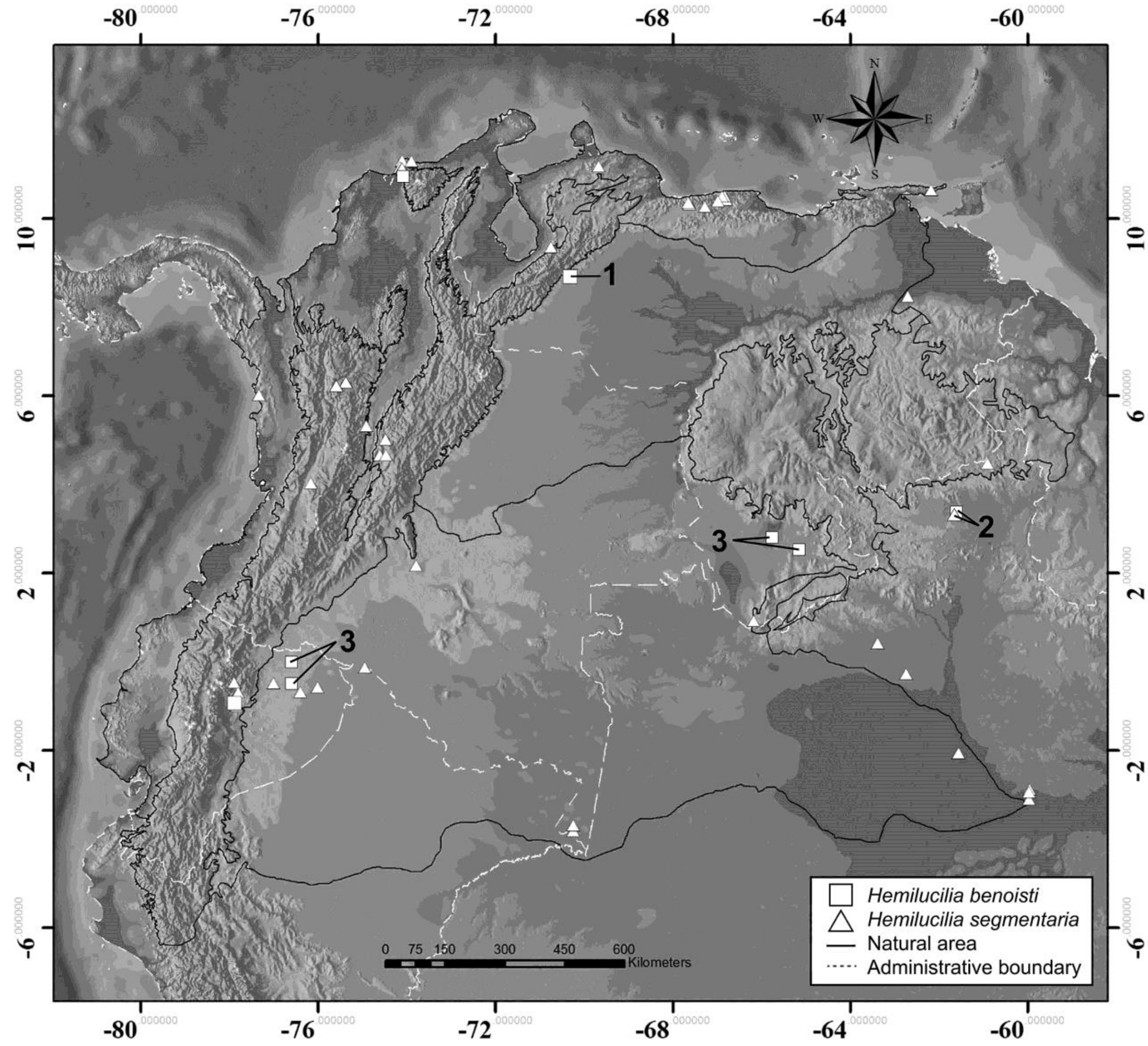


Figure 10. Map of the distribution localities for *Hemilucilia segmentaria* (Fabricius, 1805) and *Hemilucilia benoisti* Séguy, 1925 in the northwest South America. Records based in literature: **1.** Dear (1985); **2.** Carvalho & Couri (1991); **3.** Peris & Mariluis (1989).

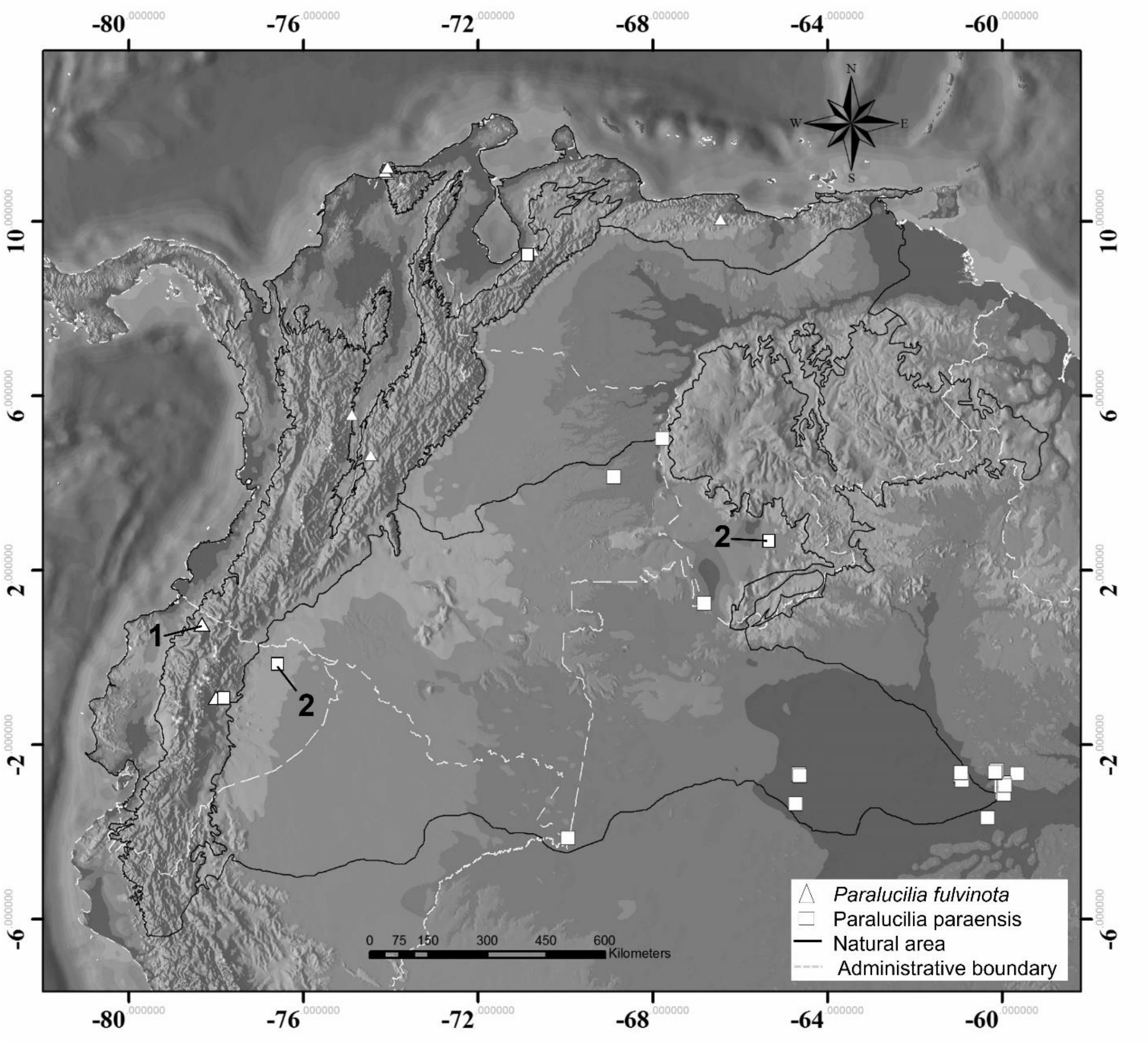


Figure 11. Map of the distribution localities for *Paralucilia fulvinota* (Bigot, 1877) and *Paralucilia paraensis* (Mello, 1969) in the northwest South America. Records based in literature: **1.** Dear (1985); **2.** Mariluis *et al.* (1994).

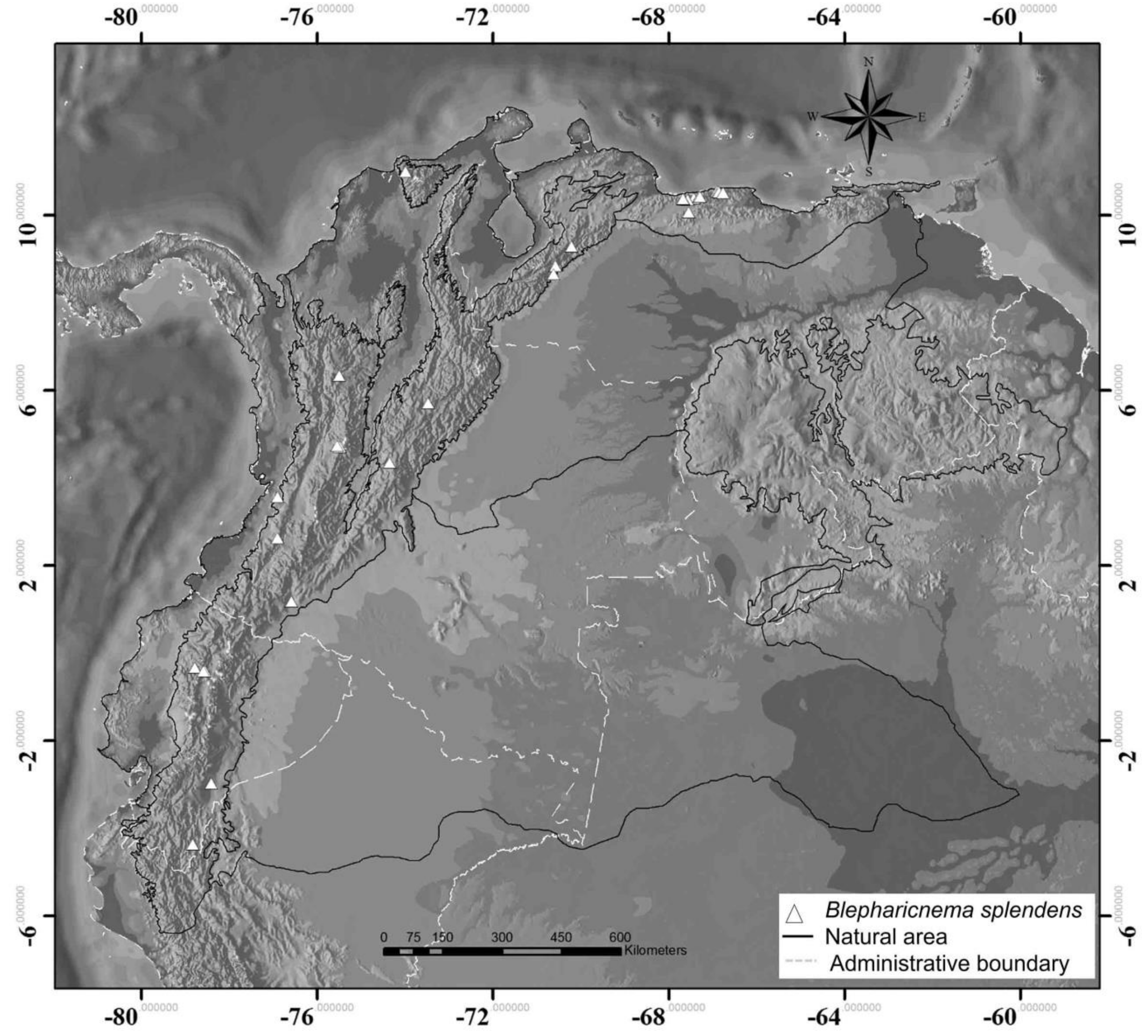


Figure 12. Map of the distribution localities for *Blepharicnema splendens* Macquart, 1843 in the northwest South America.

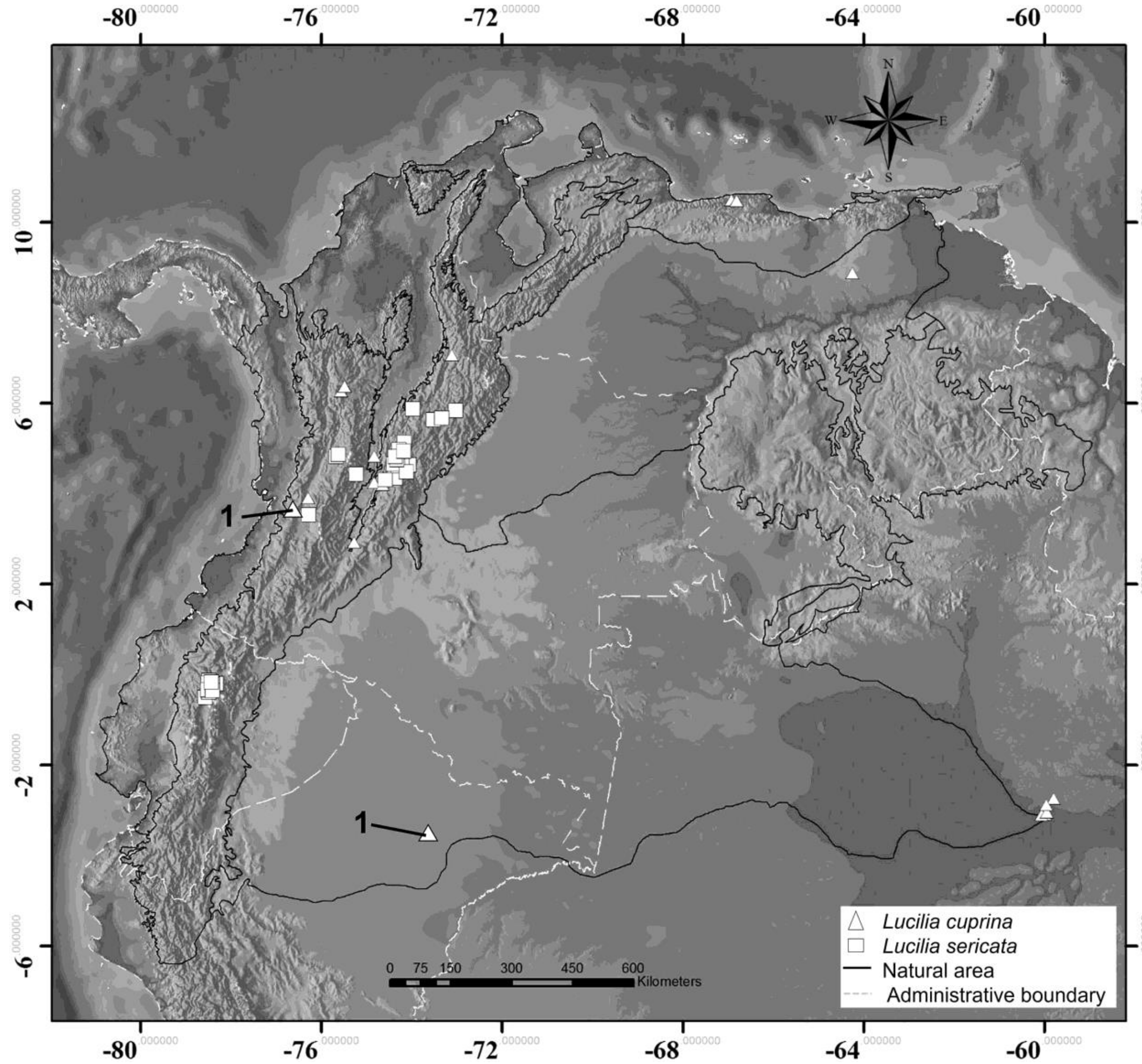


Figure 13. Map of the distribution localities for *Lucilia cuprina* (Wiedmann, 1830) and *Lucilia sericata* (Meigen, 1826) in the northwest South America. Records based in literature: **1.** Whitworth (2014)**.**

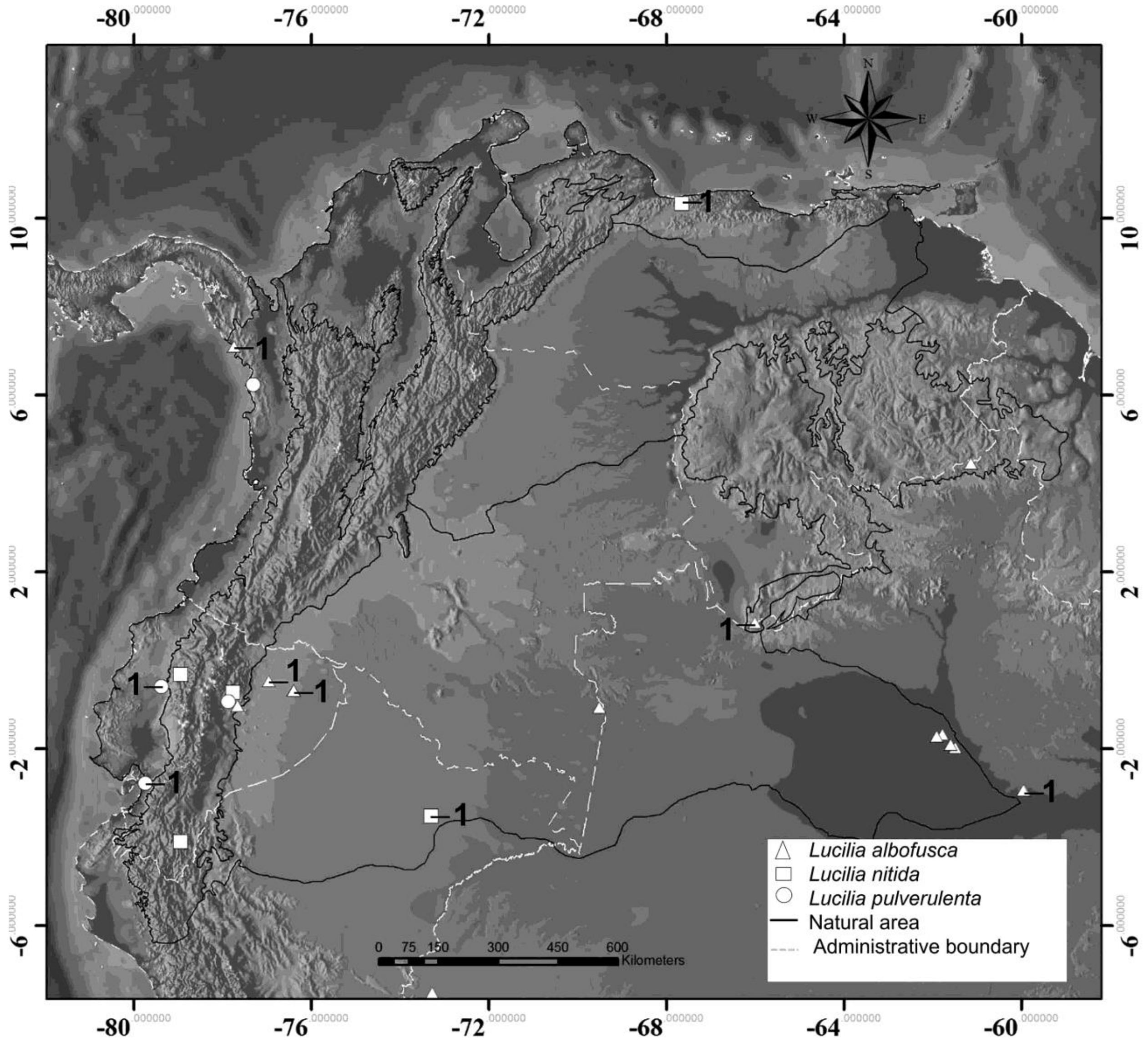


Figure 14. Map of the distribution localities for *Lucilia albofusca* Whitworth, 2014, *Lucilia nitida* Whitworth, 2014 and *Lucilia pulverulenta* Whitworth, 2014 in the northwest South America. Records based in literature: **1.** Whitworth (2014)**.**

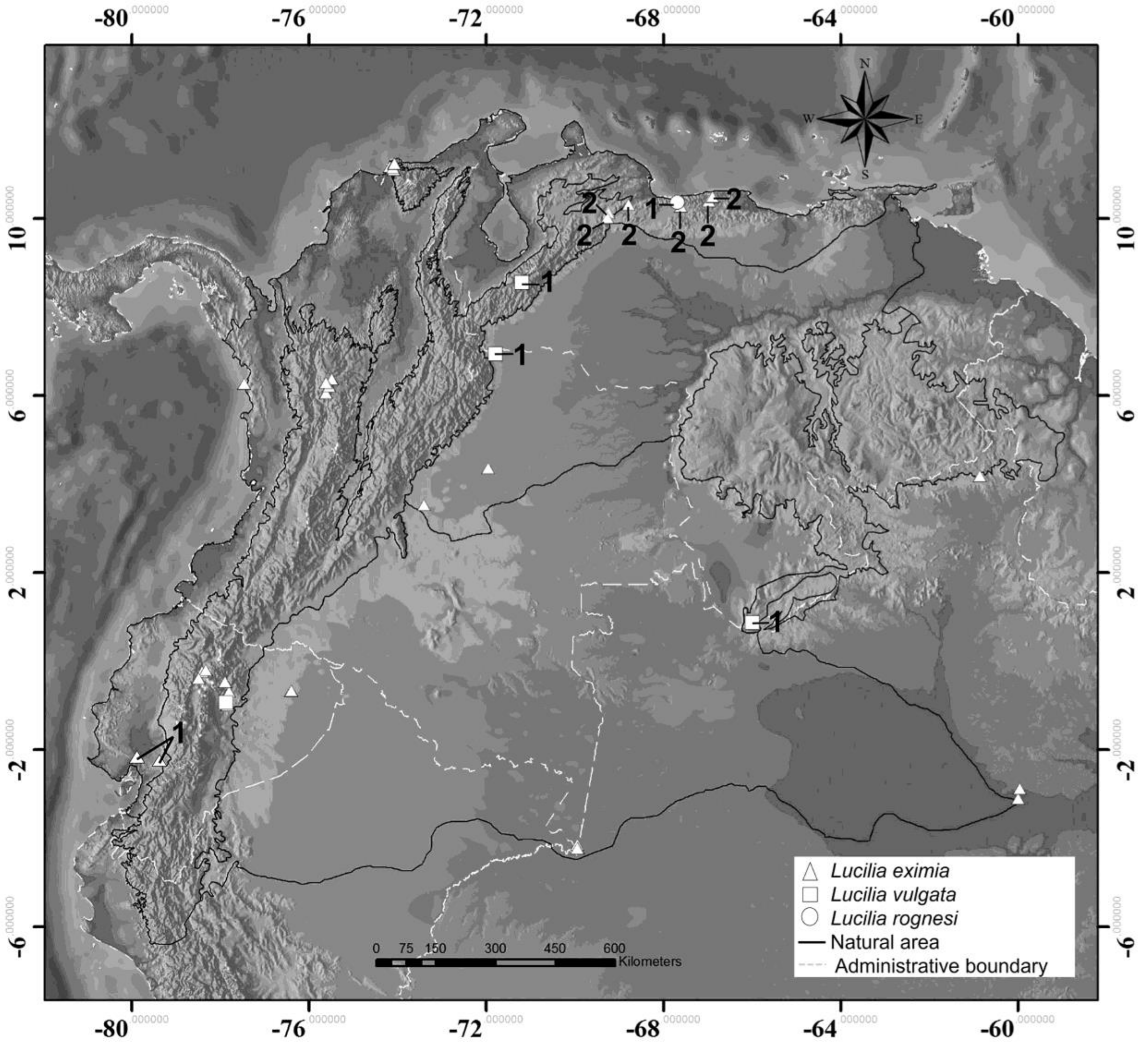


Figure 15. Map of the distribution localities for *Lucilia eximia* (Wiedemann, 1819), *Lucilia vulgate* Whitworth, 2014 and *Lucilia rognesi* Whitworth, 2014 in the northwest South America. Records based in literature: **1.** Whitworth (2014)**. 2.** Velásquez *et al.* (2017)

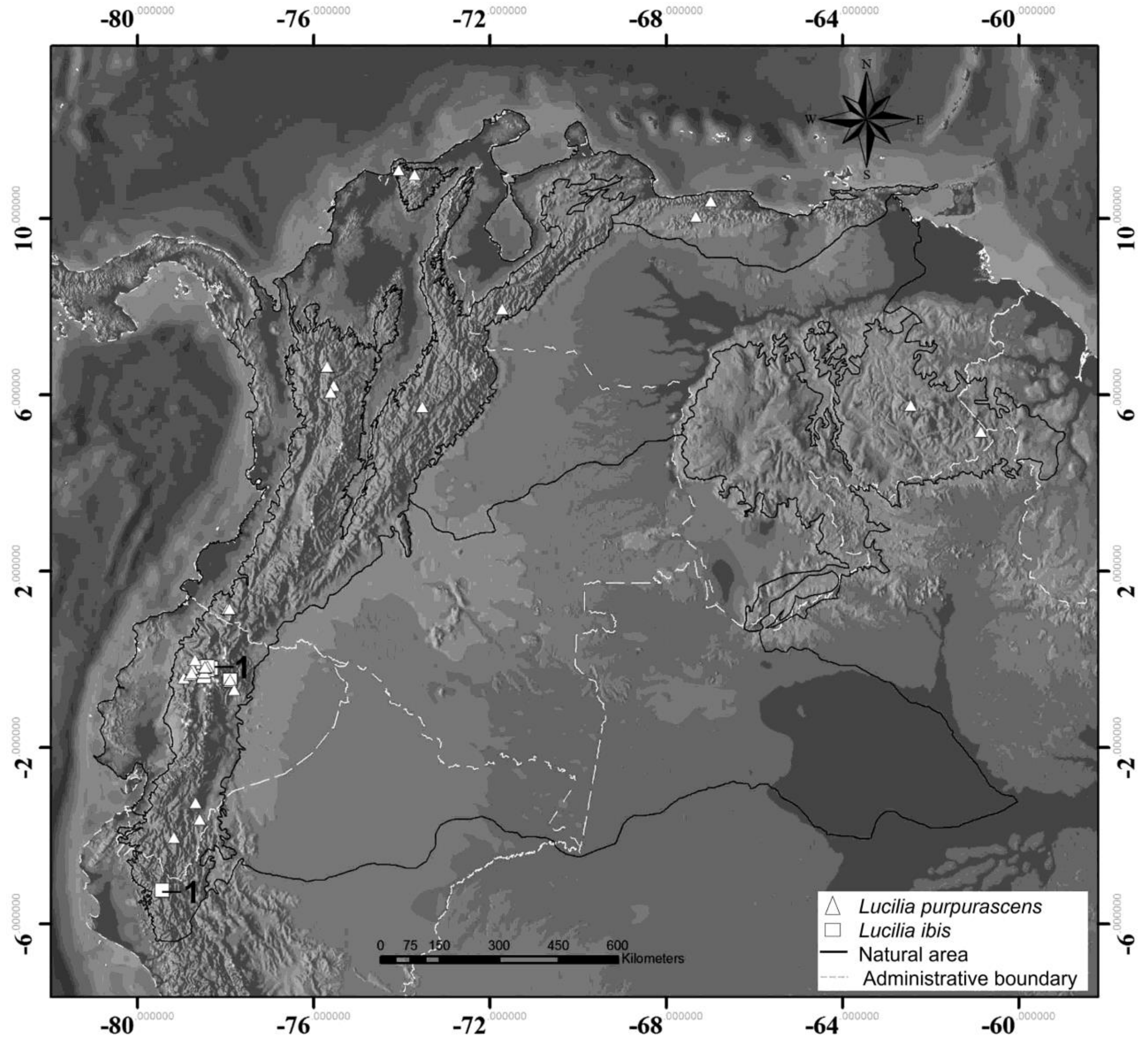


Figure 16. Map of the distribution localities for *Lucilia ibis* Shannon, 1926 and *Lucilia purpuracens* (Walker, 1836)in the northwest South America. Records based in literature: **1.** Whitworth (2014)**.**

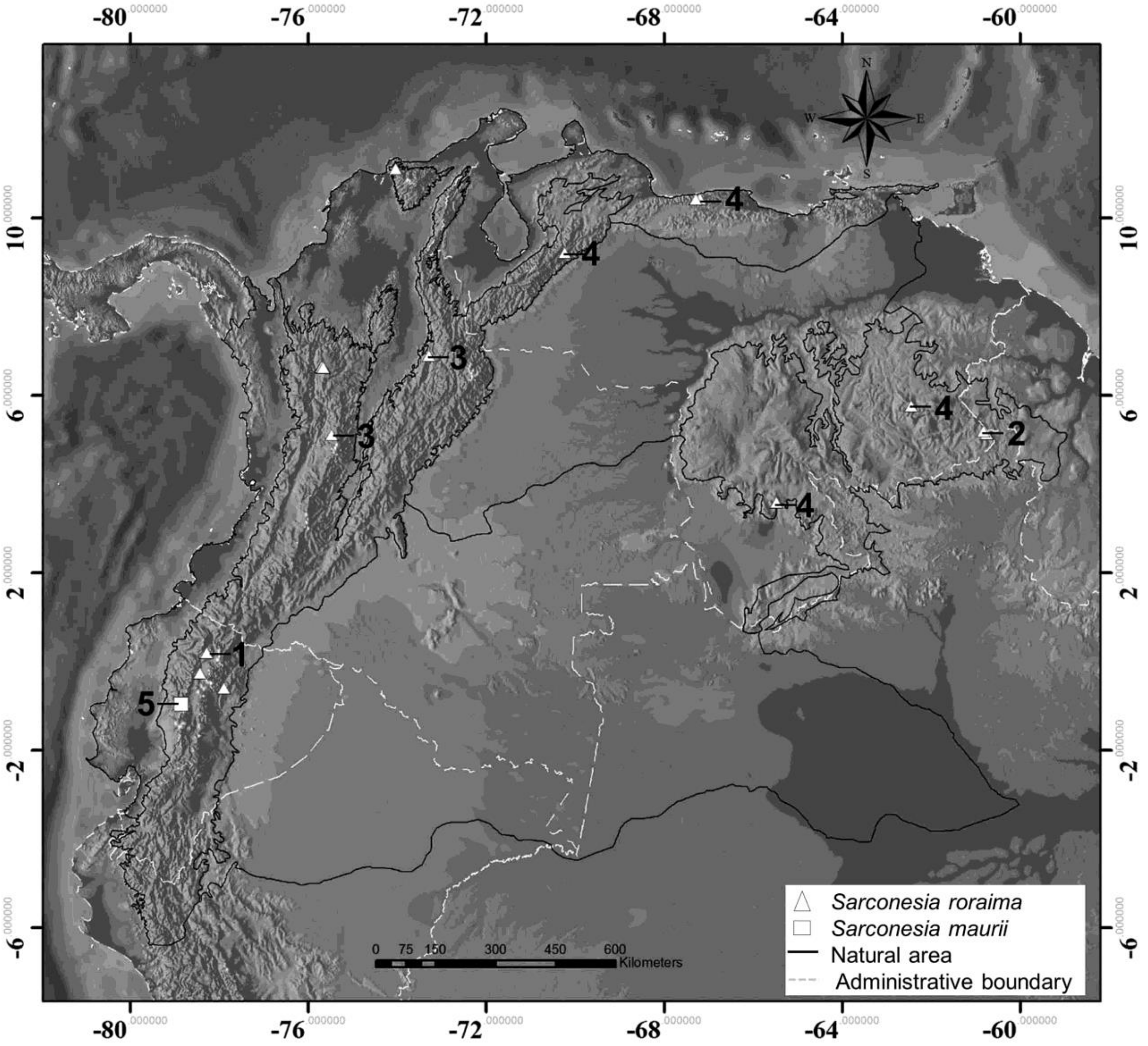


Figure 17. Map of the distribution localities for *Sarconesia maurii* Mariluis, 1981 and *Sarconesia roraima* (Townsend, 1935) in the northwest South America. Records based in literature: 1. Mello (1978); 2. Dear (1979); 3. Wolff & Kosmann (2016); 4. Velásquez *et al.* (2017); 5. Mariluis (1981).

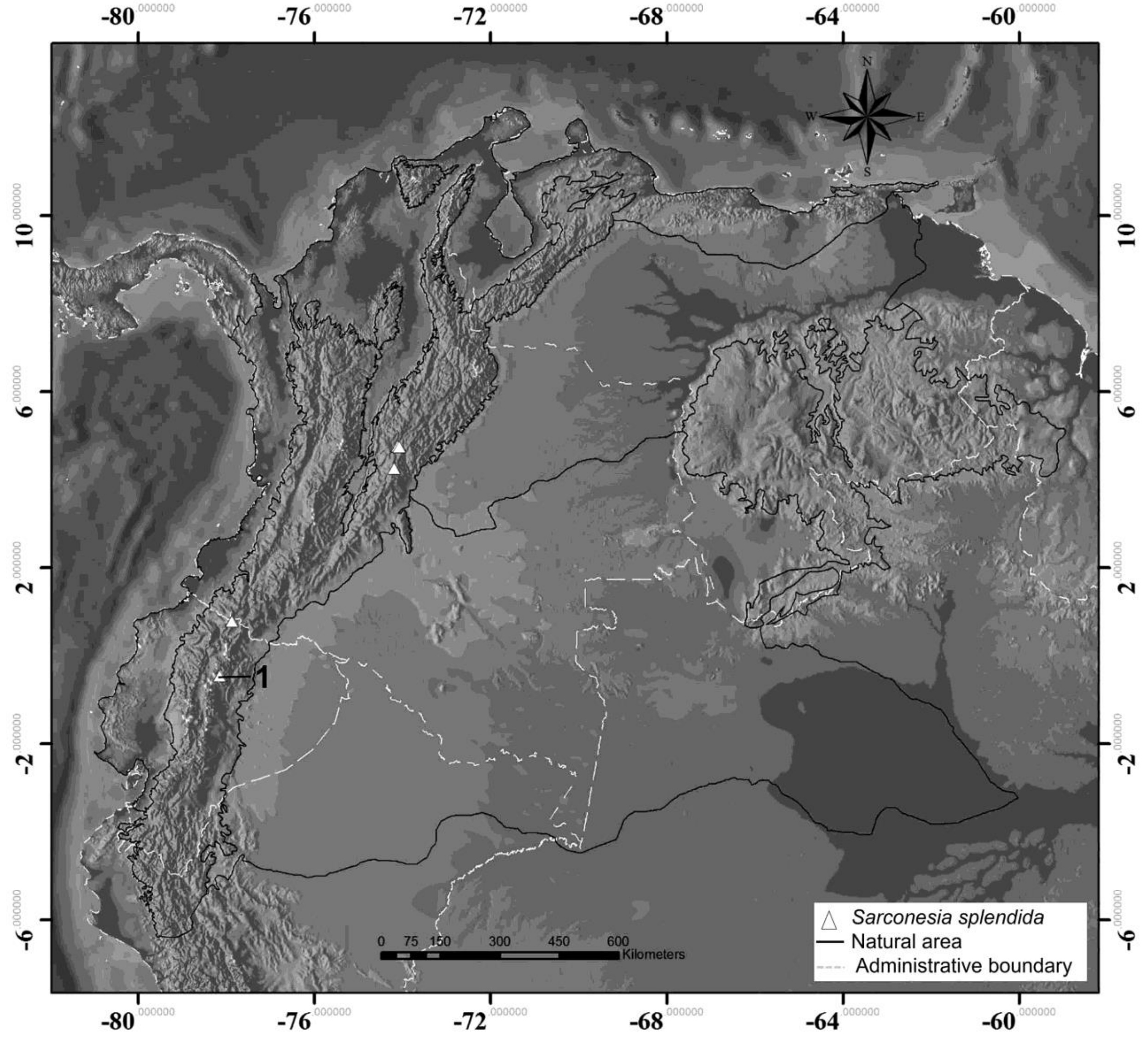


Figure 18. Map of the distribution localities for *Sarconesia splendida* (Townsend, 1918) in the northwest South America. Records based in literature: **1.** Dear (1979).

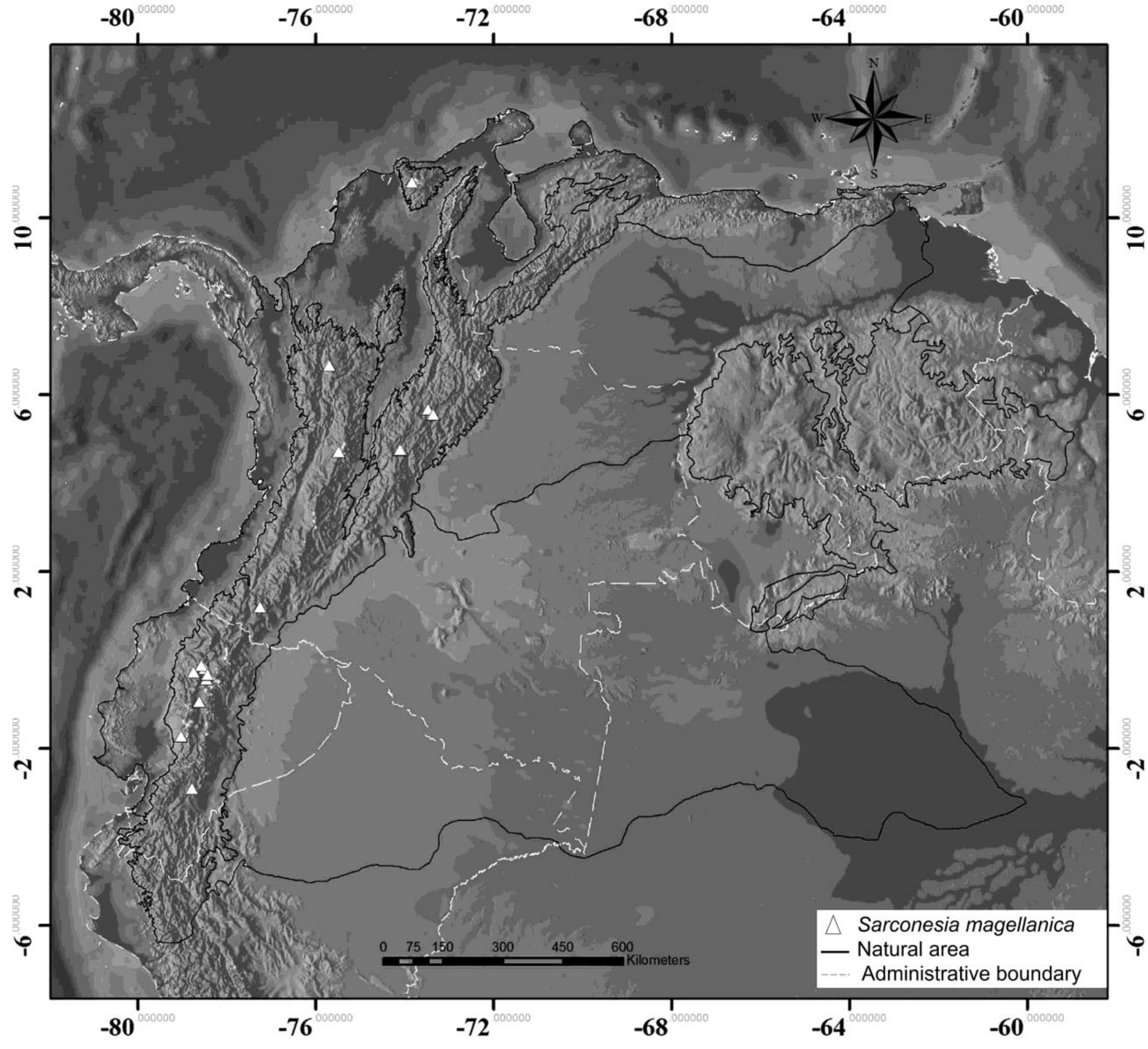


Figure 19. Map of the distribution localities for *Sarconesia magellanica* in the northwest South America.

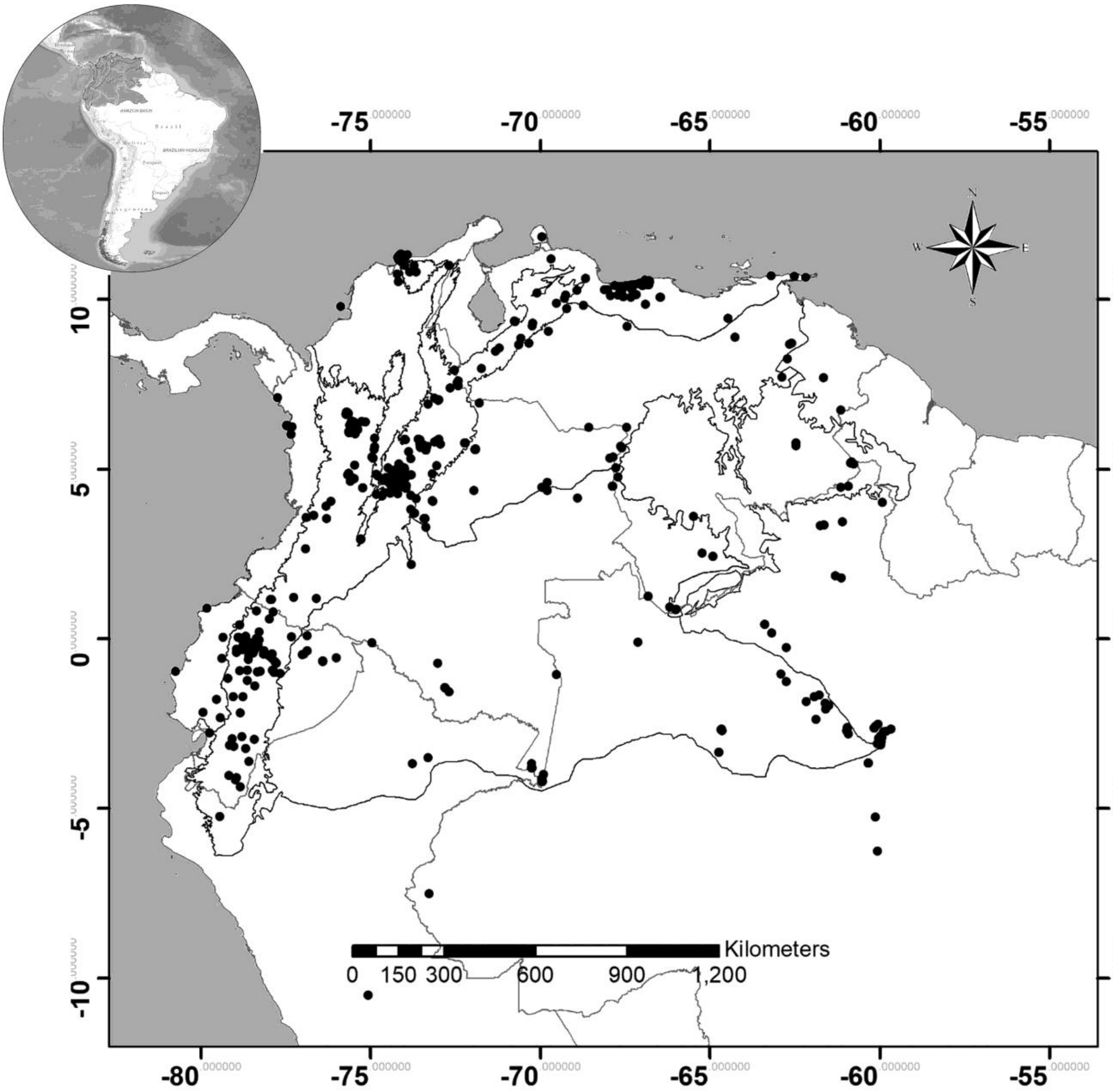


Figure 20. Map of the collection localities of blow flies in the Northwest South America

Capítulo 5

Amat, E. Gomez, G. F. Lopez-Rubio, A. Gomez L. M. & Rafael, J.A. to submit. DNA mini-barcoding for identifying blow flies (Diptera, Calliphoridae) in the Northwest South America. *Acta Tropica*.

DNA mini-barcoding for identifying blow flies (Diptera, Calliphoridae) in the Northwest South America

Eduardo Amat[1,2,] Giovan F Gómez[2], Andrés López-Rubio[2], Luz Miryam Gómez[2], Jose Albertino Rafael[1]

[1]Programa de Pós-graduação em Entomologia, Coordenação de Entomologia, Instituto Nacional de Pesquisas da Amazônia-INPA, Manaus, AM, Brazil

[2]Grupo Investigación Ciencias Forenses y Salud (GICFS). Tecnológico de Antioquia – Institución Universitaria. Calle 78B No. 72A – 220, Medellín, Colombia

Corresponding author:

Eduardo Amat. https://orcid.org/0000-0002-0962-777X Instituto Nacional de Pesquisas da Amazônia – INPA Laboratório de Entomologia Sistemática, Urbana e Forense. Av. André Araújo - Campus II – Aleixo, Manaus, Amazonas, Brasil. E-mail: ecamat@gmail.com

Highlights

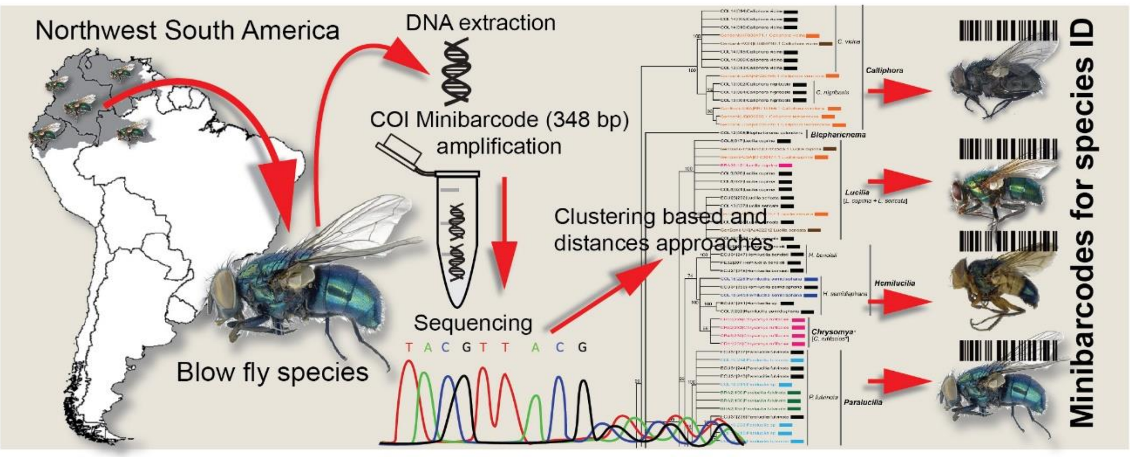
DNA-based techniques are useful and complementary to Neotropical blow flies species identification.

An alternative short sequence of mtDNA for species identification is assessed in North West South American blow flies.

The mini-barcode is highly informative for species diagnosis of most blow flies assessed, except for *Lucilia* species.

It is possible to recover DNA sequences from the mini-barcode in blow flies specimens up to 57 years preserved.

Graphical Abstract



ABSTRACT

Accurate and unequivocal taxonomic identification is an essential step to the use of insects in applied research. Blow flies are of medical, sanitary, veterinary and forensic importance. However, the Neotropical fauna is still inadequately studied and taxa identification without the required training is a difficult task, even more when current morphological keys are not suitable. The molecular based approaches had been widely accepted, especially the use of *COI* sequences as a barcodes for correct identifications. We use a shorter sequence of the mitochondrial COI gene "mini-barcode" (348 bp) to test the efficiency on North West South American blow fly species identification. The aligned data set include 142 sequences of the mini-barcode belonging to 38 specific taxa of the complete Neotropical taxonomical array. Tree and distances based approaches were performed. The tree topology was able to assign 129 sequences to a specific taxon (79% of effectiveness) while the distance approach assigned 91 (56% of effectiveness). Taxonomic and faunistic considerations by genus based in these findings are provided. Despite the mini-barcode did not reflected the phylogeny, it was efficient for the accurate identification of North West South American blow flies species, except for *Lucilia*. It was able to recover DNA information from samples up to 57 years preserved. Thus, we recommend the use of this marker on adults and immatures as an alternative methodology for taxonomic identification in the area assessed.

Keywords: carrion flies, forensic entomology, mitochondrial DNA, molecular taxonomy, species identification

Introduction

The blow flies (Diptera, Calliphoridae) are a family of dipterans encompassing approximately 1.600 species worldwide (Pape *et al*., 2011), most of them are of considerable importance due to the degree of association with man (Marshall, 2012). Some species are of medical, veterinary or sanitary importance; they are strongly attracted to excrement, secretions and decaying material, thus constantly alternate between feces and human comestibles, being an efficient mechanical vector of pathogens (Greenberg, 1973). Moreover, they cause myiasis; an infestation of alive tissue with fly larvae in man and animals (Norris, 1965). In the framework of decomposition ecology, they are the most conspicuous and active macro-organisms in the process of carcass reduction (Anderson and Cervanka, 2002) and also their colonization habits may serve as a method of calculating the post mortem interval in forensic entomology (Amendt et al., 2004; Greenberg and Kunich, 2002).

Accurate and unequivocal taxonomic identification of dipterans is an essential step for taxa recognition and their use in ecological, medical, veterinary and legal context (Wells and Sperling, 2001; World Health Organization, 2007). In this sense blow fly neotropical species identification face limitations such as relying on morphology, making this activity a difficult task (Shewell, 1987; Whitworth, 2010), especially when no updated taxonomic keys and trained personal are available. To overcome this difficulty, several approaches have considered, including the use of standardized genomic regions, also known as DNA barcodes as proposed by Hebert *et al*., (2003). with the Cytochrome C oxidase subunit I (*COI*) as the most common gene used for diagnosis and species recognition purposes in metazoans (Hajibabaei *et al*., 2007). In blow flies the use of *COI* for DNA barcoding proved its advantages and have been widely implemented with relatively good performance for species identification of forensic importance (Harvey *et al*., 2008, 2003; Nelson *et al*., 2007; Wells and Williams, 2005). However, some studies pointed the inability of the COI for distinguish among certain closely related species (Nelson et al., 2007) or species infected with the endosymbiotic bacteria *Wolbachia* (Whitworth et al., 2007). In addition, for some taxa there are certain difficulties due to the age of sample to amplify the standard barcode region by using primers of Folmer et al., (1994). More recently it is been proposed the use of an additional barcoding locus to improve the molecular taxonomic identifications including other mitochondrial or nuclear regions (GilArriortua et al., 2013; Yusseff-Vanegas and Agnarsson, 2017).

Conversely some authors had been addressed the importance of the minimum amount of molecular data required for an accurate species identification, and they had proposed the use of practical “mini-barcodes” (<650 bp) as highly informative segments for species diagnosis in several organisms (Meusnier et al., 2008). These mini-barcodes may dramatically expand the application due to the efficacy of amplification in old stored or non-adequate preserved specimens with degraded DNA (Hajibabaei et al., 2006) and recently have been used on flies of forensic importance (Grzywacz et al., 2017). Despite of the molecular information available, only a few molecular studies on DNA barcoding encompassing the Neotropical blow fly fauna had been carried out. These approaches have proven success for species of forensic importance (Marquez-Acero et al., 2017; Solano et al., 2013; Yusseff-Vanegas and Agnarsson, 2017). This study explores the variation of a short sequence of the mitochondrial COI gene ”Mini-barcode” for species diagnosis of blow flies occurring the northwest South America, considering the full taxonomic arrangement of Neotropical genera. We aim to contribute with molecular data of this mini-barcode region as an auxiliary dataset for supporting future species identification. This contribution will facilitate the use of Neotropical blow flies in the ecological, medical, veterinary and forensic context.

Materials and Methods

Samples

Individuals came from a wide range of habitats (Table 1), from urban environments to well preserved forest in 34 localities of northwest South America (Figure 1). The specimen depositories are as follows: Coleção de Entomologia, Universidade Estadual de Campinas, Brazil **[UNICAMP]**; Colección Entomológica del Tecnológico de Antioquia, Institución Universitaria **[CETdeA]**; Instituto Alexander von Humboldt, Colombia **[IAvH]**; Instituto Nacional de Pesquisas da Amazonia, Brazil **[INPA]**; Museo de Entomologia “Klaus Raven Büler” Universidad Nacional Agraria La Molina, Peru **[MEKRB]**; Museo del Instituto de Zoología Agrícola “Francisco Fernández Yépez” Universidad Central de Venezuela, Venezuela **[MIZA]**; Museo de Invertebrados, Pontificia Universidad Católica del Ecuador, Ecuador **[QCAZ-I]**; and Museo de Historia Natural, Universidad Nacional Mayor de San Marcos, Perú **[UNMSM]**. Blow flies were morphologically identified (pre-assessment assigned taxon) based on several taxonomic proposals. We followed the subfamilies classification adopted by Rognes (1997). Chrysomyiinae classification arrangement for Neotropical genera followed Dear (1985), *Chrysomya* species were identified according to Grella et al. (2015), *Compsomyiops* species were identified following the keys of Dear (1985) and González-Mora et al. (1998), *Paralucilia* species were identified according to Dear (1985) and Mello (1996), *Hemilucilia* species were identified according to Dear (1985) and

Peris and Mariluis (1989). The genera of Luciliinae followed the keys of Amat et al (2008). *Lucilia* species were identified by using the key of Whitworth (2014), *Blepharicnema* according to Mariluis (1979). *Calliphora* species were identified by using the keys of Whitworth (2012) and Toxotarsinae species following the classification and identification key provided by Dear (1979). For the area assessed we recognize five biogeographical regions based in a combination of criteria from Rivas-Martinez et al., (2011) and Morrone (2014), these are: Amazon, Andes, Caribbean, Orinoquia and Pacific. For detailed information about the specimen's repository, BOLD process ID number and GenBank Access number see the Table 1 of the supplementary material.

DNA extraction, amplification and sequencing

For each DNA extraction, we used two to three legs using a modified salting out protocol (Rosero et al., 2010). *COI* barcode region was amplified using the primers designed by Wells and Sperling (2001) PCR conditions were standardized in a Piko thermal cycler ® (Thermo Scientific) under following conditions: 0.2 mM dNTP mix, 0.4 µM of each primer (C1-J-2495 & C1-N-2800), 2.5 mM of MgCl2, 1.25 U/µL of Taq DNA polymerase recombinant,1X buffer (Thermo scientific ®, EP0402), 2µL of DNA template, and 0.7 µg/µL of bovine serum albumin for a final 20 µL volume reaction for each sample. For this reaction, the cycling conditions were 95°C for 300 s, 35 cycles of 94°C for 30 s, 50°C for 60 s, 72°C for 60 s; with an additional 72°C for 300 s and 4°C. Subsequent PCR fragments were examined by running an agarose electrophoresis gel. All positive PCR products were selected for bidirectional DNA sequencing using an ABI 3730Xl capillary automated sequencer at the Macrogen facility in South Korea.

Data Analysis

Nucleotide sequences were aligned in MEGA 7 (Kumar et al., 2016). A classic approach tree-based and two additional distances-based approaches were performed by using additional nineteen sequences of blow flies species from GenBank (Table 1 supplementary material). A dendrogram estimation based on Bayesian inference was implemented by using MrBayes 3.2 (Ronquist et al., 2012); a GTR model was used (Tavaré, 1986), employing four gamma categories, a subsampling frequency of 200, 4 heated chains and 1’100.000 heated chain. Branch support was calculated as posterior probability; the final topology was based on the majority-rule consensus tree, the outgroup was assigned by using a sequence of *Drosophila melanogaster* from the GenBank. The distances approaches involved the estimation of a threshold optimization and local minima, as a measure to calculate the barcode gap for previous genetic distance matrix, using the SPIDER package (Brown et al., 2012) available in R Studio 1.1.419 (RStudio Team, 2015). Finally the efficacy of the mini-barcode *COI* region to discriminate species was tested using Nearest neighbor (NN), Best Match (BM), Best Close Match (BCM) and All Species Barcode (ASB) criteria using the Automatic Barcode Gap Discovery (ABGD) (Puillandre et al., 2012). Subsequently, some individuals were taxon re-assigned according to considerations based on the two approaches “Post-assessment assigned taxon” from above (Table 1 supplementary material). Thus, the correspondence between one taxon identified or morphotype with a well-formed cluster in the tree and one group under the distance-based analysis allowed us to confirm the species assignation or to detect a miss assigning. The intra and interspecific distances among the taxa grouped by genus are listed in Tables 3 and 4.

Results and discussion

The barcoding dataset included 162 sequences (twenty from GenBank), assigned *a priori* to 38 specific taxa (8 morphotypes), the number of specimens included in the analysis by taxon varied from a single individual to seventeen (Table 2) covering a wide geographical range of northern south America (Figure 1) and the complete taxonomic array for neotropical Calliphoridae fauna. The primers amplified 348 bp of the of the 3´*COI* gene at positions 1001 to 1348 based on the NCBI reference sequence NC_019573 of the complete *COI* gene of *Lucilia cuprina*. Amplification of this mini-barcode was successful for specimens of a wide range of collection date (2-57 years) and tissue preserved in several conditions (dry, alcohol and freezing). This short sequence allowed us to identify species and recognizing morphological misidentifications (see discussions by taxa below). The tree-based approach was able to assign 129 sequences to a specific taxon (79% effectiveness), whereas the distance-based approach was able to assign 91 (56% effectiveness). The post-assessment assigned taxa of both approaches by specimen are listed in the Supplementary material (Table 1). The use of the mini-barcode proved to be highly efficient for the accurate identification of Neotropical blow flies, except for *Lucilia* species. When the latter species were removed from the analysis, the resulting tree and the distance-based approaches reach 100% and 90% of success, respectively. The Bayesian inference tree (Figure 1) does not agree with the classical taxonomic proposal of genera within subfamilies but recovered *Calliphora*, *Compsomyiops*, *Chloroprocta*, *Paralucilia* and *Sarconesia* as monophyletic clades. In contrast, *Chrysomya*, *Cochliomyia*, *Hemilucilia* and *Lucilia* were paraphyletic, however this condition does not affect the molecular identification of their species occurring in the study area except for those of the *Lucilia* genus, since the identification at the genus level is 100% reliable based in morphology proposed in current taxonomic keys. The molecular data allowed to identify four specimens previously not assigned to known species. Hence, specimens of *Paralucilia* sp. N° 81, 82 and 86 (Supplementary file) were identified as *Paralucilia fulvinota*, and the specimen of *Hemilucilia* sp n° 76 (Supplementary material 1able 1) was identified as *Hemilucilia semidiaphana*. The *Lucilia* morphospecies identities remain uncertain for all specimens with two post-achrostical seta excepting *L. ibis* ans *L purpurascens*. A morphological misidentification was found related to an Amazonian specimen identified as *Paralucilia pseudolyrcea* (N° 95) and latter assigned into the *Paralucilia paraensis* group. Further discussion by genus below.

Blepharicnema

According to the tree topology *B. splendens* is a sister group of all clusters taxa of the current Chrysominae, Luciliinae and Toxotarsinae excepting *Calliphora* (Calliphorinae) and *C. hominivorax* (Figure 2). Furthermore, the interspecific distance among the species of *Lucilia* (x= 9.74) (Table 5) its sister taxon, supported *Blepharicnema* as not related to *Lucilia* species, contrasting to the molecular approach of Lea-Charris et al (2016) based in nuclear ITS2, where all cases *B. splendens* was grouped within *Lucilia*. Our data here exposed and the particular diagnostic morphology of this species included the considerable size among others (Mariluis, 1979), led us to keep considering this Andean endemic genus (Amat and Wolff, 2007) as a monotypic taxon.

Calliphora

Obtained data for *Calliphora* species was similar based on the two approaches and morphology. The resulting topology recovered three cluster strongly supported, two of them corresponding to the *Calliphora* species occurring in northern South America *Ca. nigribasis* and *Ca. vicina* respectively. A barcode gap was observed with a threshold value of 2.85% (Table 3) in addition to all the intraspecific distances that were less than 1.29% divergent (Table 4). The ABGD separated three groups, it was unable to assign to specific taxon for four sequences (Table 3). *Ca. nigribasis* and *Ca. vicina* were the only species occurring in northern South America and they can fairly be differentiated by using the mini-barcode. We consider the current taxonomic key of Whitworth (2012) as suitable for morphological identification.

Chloroprocta

The tree topology recovered *Chloroprocta* specimens from a wide geographical range in a monophyletic clade jointly with the old world *Lucilia* clade as sister groups (Figure 1). This condition does not affect the molecular identification since *Lucilia* and *Chloroprocta* are easily differentiated based in morphology. The intra-specific distance found in this study was relatively high (0.81%) in comparison with values of others Neotropical species of Chrsymomyiinae (Table 4). The *Chloroprocta* monotypic genus involves the Neotropical widespread species *Chloroprocta idioidea* according to Dear (1985). Although previous authors considered the existence of more species (Hall, 1948; Shannon, 1926), Dear documented a remarkable variation in coloration depending on the geographical distribution, but yet considered it as a single species. Furthermore, in Peru, (Baumgartner and Greenberg, 1985) detected two types of specimens differing in the size of anterior eyes facets. Recently

Yusseff-Vanegas and Agnarsson (2017) suggested the existence of two or three different entities based on molecular data (*COI* and ITS2) from Caribbean specimens. Our data together with the high morphological variation observed may suggests the existence of cryptic species for *Chloroprocta* in this region, despite no geographical structuration was evidenced based on the mini-barcode. Further studies including specimens across the distribution range using detailed morphological analysis and molecular data (multi locus) are necessary to elucidate the valid taxonomic status of *Chloroprocta* as monotypic taxon.

Chrysomya

Despite the tree topology recovered *Chrysomya* especimens as a paraphyletic group into two clusters (Figure 1), the molecular identification among them was successful. The first cluster encloses the *C. rufifacies* specimens in a polytomy relatively low supported (56%) and closely related to *H. semidiaphana*. The second cluster encloses [*C. albiceps +C megacephala +C putoria*] each strongly supported (100%, 99%, 100% respectively) and clearly differentiated. This grouping pattern was in agreement with the morphological identification. By the other hand, the ABGD approach was able to retrieve five groups; two of them encompass specimens previously identified as *C. albiceps*, consequently, two sequences were not assigned to a specific taxon (Table 3). The four introduced species of *Chrysomya* in the new world were clearly identified by using the mini-barcode. Molecular data also support the morphological key for species identification proposed by Grella et al. (2015). *C. rufifacies* was previously reported in Colombia by (Barreto et al., 2002), in Ecuador by (Tantawi and Sinclair, 2013) and in Venezuela by (Thomas and Ferrer-Paris, 2015). Our data, together with the lack of *C. rufifacies* specimens in an exhausted survey of 3.119 specimens of *Chrysomya* *albiceps* from 70 localities from all natural region of northern south America (Amat unpublished data) allowed us to suggest that *C. rufifacies* is not yet stablished or does not occur in South America. Consequently, previous records above mentioned are highly doubtful.

Cochliomyia

Both approaches were identical to morphological identification. Although, the topology recover the genus in a paraphyletic pattern, the molecular identification of the species was not affected. The screwworm *C. hominivorax* resulted as the sister group of the rest of Calliphoridae taxa occurring in the area, and the secondary screwworm *C. macellaria* closely related to *Compsomyiops* species. A barcode gap was observed with a threshold value particularly high of 5.6 % (Table 3). Two species of *Cochliomyia* have been recorded in northern South America (Dear, 1985). They were successfully identified in our analysis using the mini-barcode. Thus, keys for morphological identification of this group are optimal for their species recognition (Amat et al., 2008; Guimarães and Papavero, 1999; Whitworth, 2010). Accordingly, to the recent *Cochliomyia* phylogenetic hypothesis, the position of *C. hominivorax* is basal to the rest of *Cochliomyia* species (Yusseff-Vanegas and Agnarsson, 2016). Our results corroborate this divergence among these species and reveal noticeable molecular differences between *C. hominivorax* and *C. macellaria* (Table 4). The life history of *C. hominivorax* from being an obligate parasite of vertebrates (Guimarães and Papavero, 1999) and the evolution of parasitism within the family may certainly influence the current genetic divergence (Stevens and Wallman, 2006).

Compsomyiops

Tree based approach obtained a monophyletic cluster [*C. verena* + *C. callipes*] strongly supported (100%) and closely related to *C. macellaria* (Figure 2). Besides ABGD approach was capable to distinguished two groups which agreed with the morphological identification (Table 3). And a barcode gap was observed with a threshold value of 1.07%. *Compsomyiops* is an endemic tricky genus from the New world, comprising six species, most authors had declared the extreme difficulty to find characters for species definition (Dear, 1985). Due to the lack of molecular data for these taxa the use of the mini-barcode must be used with caution, our data clarify differentiation among these two specie. However, it is strongly recommended for future morphological and molecular detailed studies to include *Compsomyiops alvarengai* Mello 1968 and *Compsomiops boliviana* Mello 1968 because of their apparently sympatry and co-occurrence in highlands of this region as well as the rest species from others localities. Thus, including the complete set of South American species will elucidate their valid taxonomic status. The available taxonomical keys of Dear (1985) and González-Mora et al., (1998) must be use with caution for taxonomical purposes.

Hemilucilia

The tree topology was able to recover two groups of *Hemilucilia* strongly supported: 100%, 100% respectively and one paraphyletic clade closely related to *Chrysomya rufifacies* (Figure 2) as the morphology did. Despite this pattern, the molecular identification among *Hemilucilia* species was not affected since *Chrysomya* is morphologically undoubtedly distinguish to *Hemilucilia.* While the ABGD approach generated four group, this way were not possible assign to a specific taxon two sequences. A barcode gap was observed with a threshold value of 3.75% (Table 3); *H. semidipahana* displayed the highest intraspecific divergence within the genus (1.96%) (Table 4). Four species of *Hemilucilia* occur in the Northern South America (Peris and Mariluis, 1989). *Hemilucilia souzalopesi* Mello 1972 and *Hemilucilia melusina* Dear 1985 were not included here since the first occurs only in southern South America and the second one is very rare and it was not possible to recover practical tissue. The performance of the mini-barcode was highly acceptable for species recognition; particularly, the tree-based approach recognized *Hemilucilia* sp as *H. semidiaphana* (Figure 1). These two sequences were closely related (2.79% divergence), value that overlaps the gap threshold (3.75%). However, this interference did not affect the post assessment assignation in the tree approach, but remained uncertain for the distance-based approach. *H. semidiaphana* a highly polymorphic species varying geographically in coloration and wide frons head-width ratio among others (Dear, 1985)), the specimen here revised and a priori assigned to the morphospecies was highly variable in coloration and ground color, it did not match any species on the key. In consequence, we do not exclude a possible species complex. Further detailed morphological and molecular studies including specimens of a wide range of localities are necessary to clarify the phylogeny and taxonomic valid status.

Paralucilia

While the morphology distinguished four morphotypes, the two approaches were similar separating two evident groups or clusters. The tree topology recovered a monophyletic clade [*P. fulvinota* + *P. paraensis*] strongly supported (98%) (Figure 2) as the ABGD did (Table 3). The barcode gap indicated a threshold value of 2.50%. The use of mini-barcode was satisfactory for the species recognition, inclusive for species whose specimens are living in sympatry at the locality 2 (Figure 1). The mini-barcode allow to identify the morphotypes and recognized a missidentfication since the specimen (N°95) was previously identified as *Paralucilia pseudolyrcea* by Dr. Rubens Pinto de Mello, one of the most renamed Neotropical blow fly taxonomist, and the specimens N° 81, 82 and 86 were previously assigned to an unknown morphotype. Additionally, the inter-specific distances among *P. pseudolyrcea* and *P. paraensis* (0.1% divergence) and among *Paralucilia sp.* and *Paralucilia fulvinota* (0.6 % divergence) (Table 4) were remarkably lower overlapping the threshold barcode gap (Table 3) corroborating the molecular id. These misunderstandings reflect the lack of reliable morphological characters in the current taxonomical keys; thus, the mesonotum with or without distinct vittae, together with coloration patterns of the anterior spiracle, face and lower calypter are not enough optimal combination of characters for species identification. It is essential to include the rest of *Paralucilia* species to clarify the current taxa validity based on molecular and detailed morphological data. Current keys must be used with caution since the entire morphological variation of *P. fulvinota* is not currently included and additionally P. *pseudolyrcea* could be confused with *P. paraensis* as here exposed.

Lucilia

Both approaches were highly contrasting with the morphological identification, while the morphology identified 16 taxa (Table 2), the tree based approach recovered the genus as paraphyletic, with 3 major clades and 4 clusters strongly supported; 100%; 100%, 99% and 99% respectively (Figure 2). In addition, the ABGD separated sixteen groups unable to assign twelve specimens to a specific taxon (Table 3) and including specimens of *L eximia*, *L. pulverulenta*, *L, nitida*, *L vulgata* and morphotypes 2, 3, 4, 5 and 6 in the same group. A barcode gap was observed with a threshold value of 2.95%. Despite the recent detailed revision of Neotropical *Lucilia* (Whitworth, 2014), the morphological identification was challenging and contradictory with the molecular data. The mini-barcode had a deficient performance in this genus. While the distance approach evidenced a lumping classification. The tree approach had barely acceptable resolution recognizing in a separate some clusters, as the sister species with three post-sutural acrostichal setae [*L. sericata* + *L. cuprina*]; the arctic species [*L. caesar* + *L. illustris*] and the rest of the *Lucilia* species with two post-sutural acrostichal setae including a particular clade with a weak support (61%) of Andean species [*L. purpuracens* + *L.ibis*]. Our findings corroborate the results of Whitworth (2014)) where the barcode did not validate all morphological identifications, and also those of Wells et al., (2007) where paraphyletic grouping are recurrent. In addition, it is possible that Neotropical *Lucilia* species are grouped in several species complexes or cryptic species. Further molecular studies including additional molecular markers (multi-locus) and detailed morphological studies are still necessary to resolve the *Lucilia* taxonomy in the New World.

Sarconesia

The three topology retrieved for the *Sarconesia* species was in agreement with the morphologic identification. The genus was recovered as monophyletic [*S. splendida* + [*S. Roraima* + *S. magellanica*]] and each species group strongly supported; 100%, 100% and 98% respectively (Figure 2). While the ABGD recovered four groups, with four sequences not assigned to a specific taxon. And the threshold value identified for the barcode gap was 1.67%. (Table 3). The Systema Dipterorum (Pape and Thompson, 2017) recognize the genus *Sarconesia* as valid and unique of Toxotarsinae, in agreement with the taxonomical classification proposed by Dear (1979). In the last decades, the systematic position of Toxotarsinae genera was controversial. The species were usually considered or classified in several monotypic genera (Amat, 2009; Amat et al., 2008; Kosmann et al., 2013; Lopes and Albuquerque, 1982). Based on the average percentage among *Sarconesia* species 5.52% (Table 4) and compared with the distances among *Calliphora* (5.72%) which is a genus of high altitude Calliphorinae and sister group of Toxotarsinae (Marinho et al., 2012; Singh and Wells, 2013), we suggest preliminary that the most adequate taxonomical arrange is to consider it as valid, corroborating the proposal of Dear (1979). The high intraspecific value of *Sarconesia magellanica* gave rise to two groups; however, the tree based recovered them as a monophyletic clade. This species is widely distributed from Chile to Colombia and likely, separated populations have evolved separately since populations in austral regions occur at the sea level, while in proximities of the equatorial line it occurs in the range of 1800-4000 m (Baumgartner and Greenberg, 1985). An integrative taxonomy approach is required to clarify either mitochondrial variations are the result biogeographical processes at the intraspecific level.

A comprehensively morphology-based knowledge is needed including molecular multi locus data in order to separate and recognize accurately the species of *Compsomyiops*, *Paralucilia*, *Hemilucilia* and *Lucilia*. We provide the first mini-barcode reference library for nearly 60% of Neotropical blow fly species described. Despite the mini-barcode was unable to reflects recent blow fly phylogenies proposals (Marinho et al., 2012; Singh and Wells, 2013, 2011) , it is easily recovered from even old specimens (57 year of dry storage), it support to confirm recognized species and to associate co-specific specimens and constitutes a baseline to complement the taxonomic identification in future studies. The mini-barcode will also be helpful to associate immature stages to specific taxa and recognize their complete life stages, a relevant task in veterinary, medical and forensic entomology. In adult flies, we recommend the use of the classic morphology for genera identification purpose prior the use of the mini-barcode. For immatures, the mini-barcode must be use with caution since some not related species share a high amount of DNA information as it was evidenced in the paraphyletic clades.

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Figures

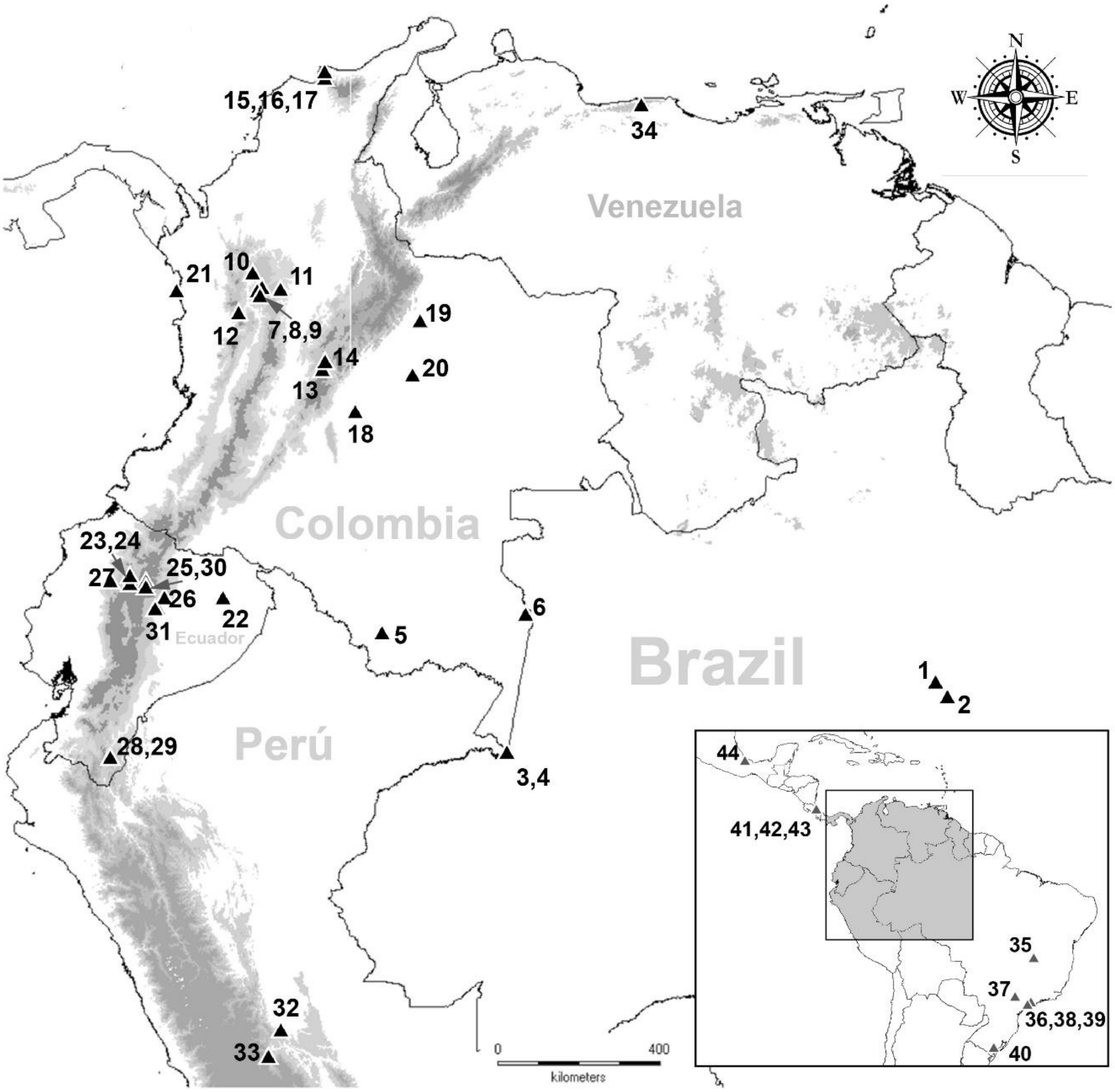

Figure 1. The sampling localities of the Northwest South American blow flies specimens used for the molecular analysis.

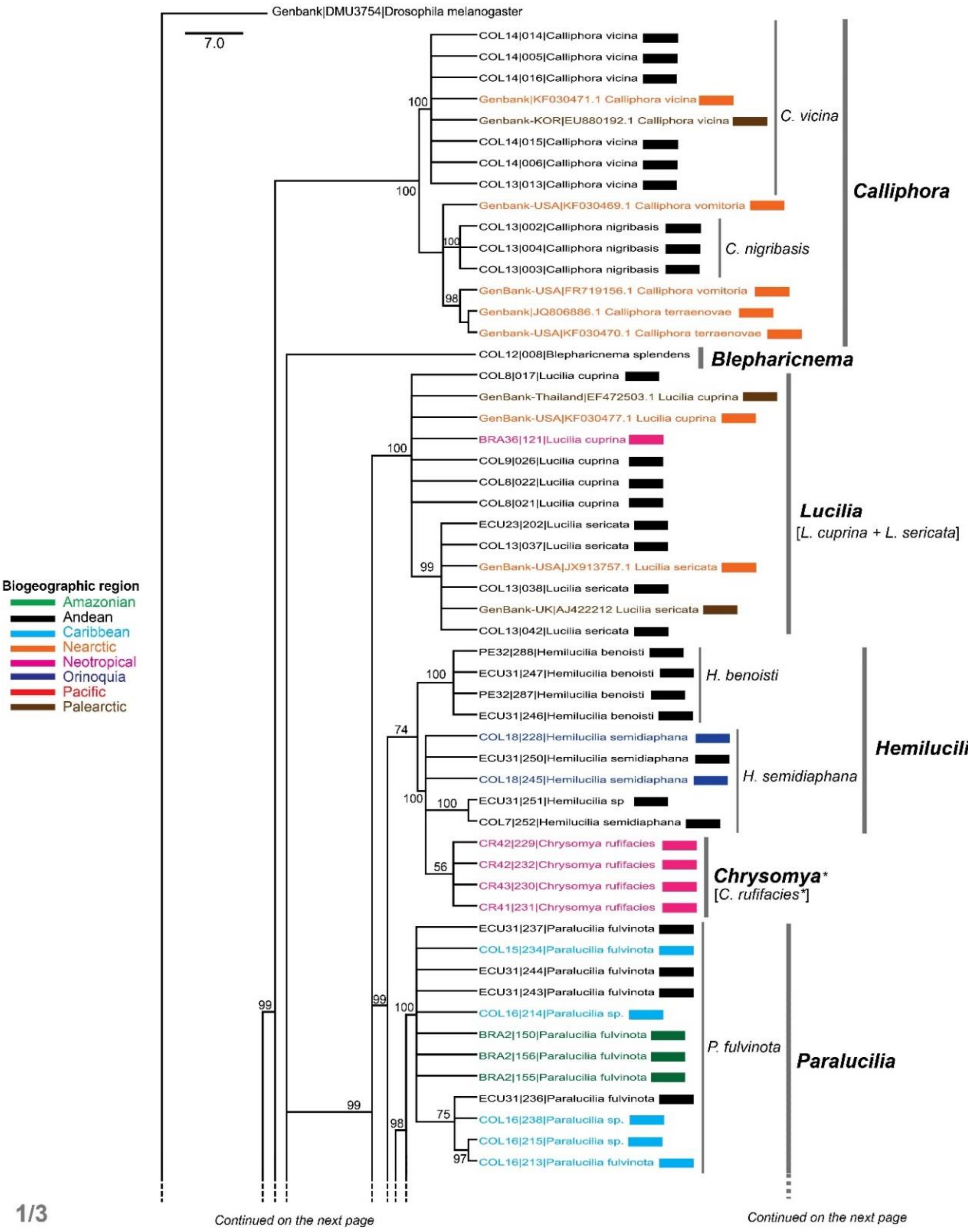

Figure 2. Bayesian inference tree of the Northwest South American Blow flies based on 348 bp of Citochrome Oxidasa subunit 1 (*COI*). Numbers are the branch support values; abbreviation of countries name as follows: **BRA**: Brazil, **COL**: Colombia, **ECU**: Ecuador, **PE**: Peru, **CR**: Costa Rica, **MEX**: Mexico, **SWE**: Sweden, **VEN**: Venezuela. Numbers following the abbreviation correspond to the locality number at table 1. *introduced taxon.

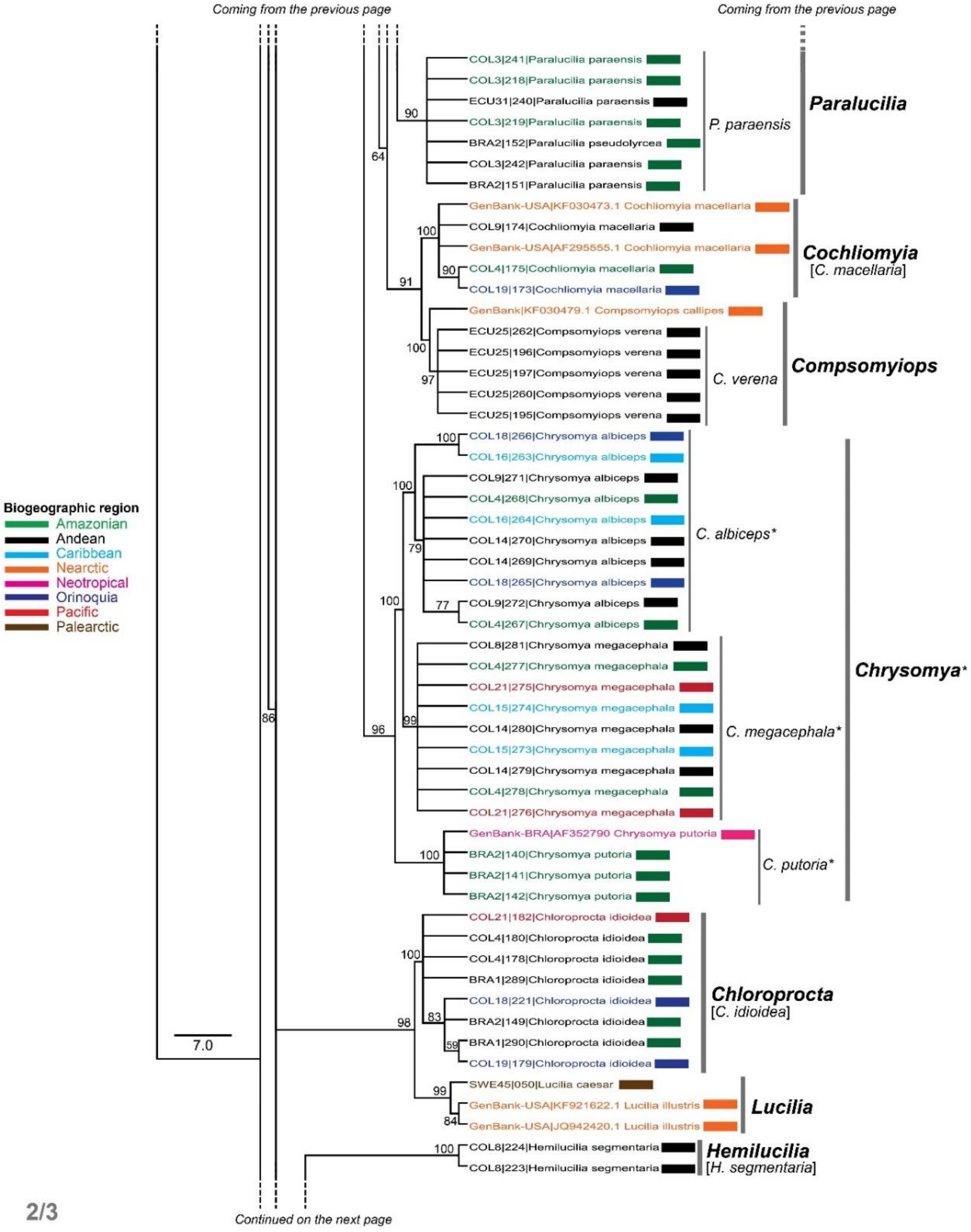

Figure 2. (Continuation). Bayesian inference tree of the Northwest South American Blow flies based on 348 bp of Citochrome Oxidasa subunit 1 (*COI*). Numbers are the branch support values; abbreviation of countries name as follows: **BRA**: Brazil, **COL**: Colombia, **ECU**: Ecuador, **PE**: Peru, **CR**: Costa Rica, **MEX**: Mexico, **SWE**: Sweden, **VEN**: Venezuela: Venezuela. Numbers following the abbreviation correspond to the locality number at table 1. *introduced taxon.

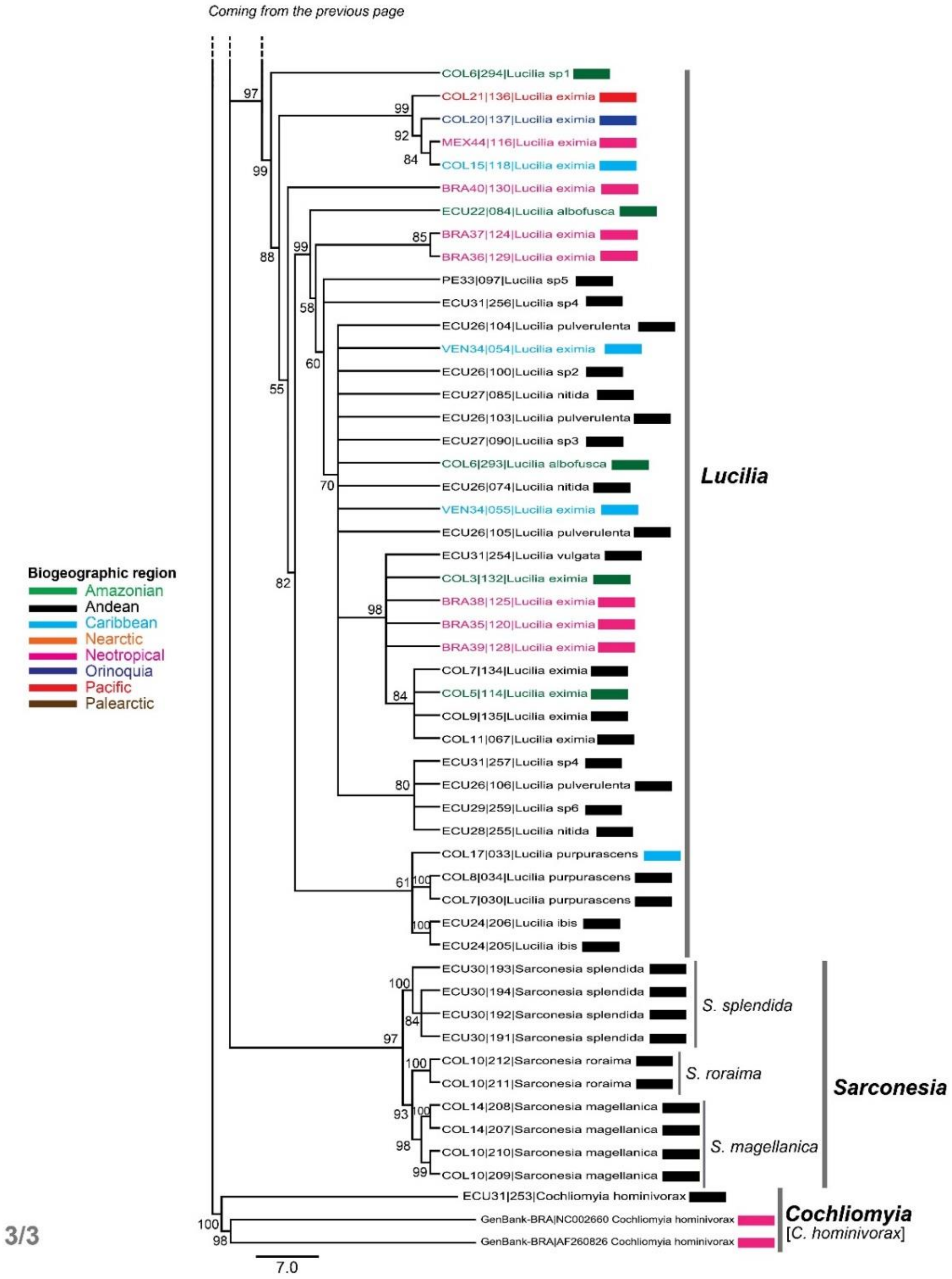

Figure 2. (Continuation) Bayesian inference tree of the Northwest South American Blow flies based on 348 bp of Citochrome Oxidasa subunit 1 (*COI*). Numbers are the branch support values; abbreviation of countries name as follows: **BRA**: Brazil, **COL**: Colombia, **ECU**: Ecuador, **PE**: Peru, **CR**: Costa Rica, **MEX**: Mexico, **SWE**: Sweden, **VEN**: Venezuela: Venezuela. Numbers following the abbreviation correspond to the locality number at table 1. *introduced taxon.

Table 1. Geographical and ecological regionalization of sampling localities; m: meters above sea level.

N° locality	Country	Province	Locality Name	Natural region	Coverage	Latitude	Longitude	Elevation (m)
1	Brazil	Amazonas	ZF2	Amazon	Amazon rain forest	2°38'14.06"S	60° 9'27.06"W	110
2	Brazil	Amazonas	Reserva Forestal Adolpho Ducke	Amazon	Amazon rain forest	2°55'54.00"S	59°55'54.53"W	90
3	Colombia	Amazonas	Km 8	Amazon	Amazon rain forest (clearance)	4°10'0.96"S	69°56'56.30"W	80
4	Colombia	Amazonas	Leticia	Amazon	Urban	4°13'0.24"S	69°56'4.68"W	80
5	Colombia	Amazonas	La Chorrera	Amazon	Amazon rain forest	1°27'30.75"S	72°47'29.78"W	150
6	Colombia	Vaupes	Estacion Biologica Mosiro-Itajura	Amazon	Amazon rain forest	1° 3'60.00"S	69°30'60.00"W	60
7	Colombia	Antioquia	Cola del Zorro	Andean	Planted forest in Urban area	6°12'19.70"N	75°32'43.90"W	1930
8	Colombia	Antioquia	Copacabana/Ankon	Andean	Suburban area	6°22'7.10"N	75°29'22.30"W	1405
9	Colombia	Antioquia	Pajarito	Andean	Suburban area	6°17'10.70"N	75°36'43.70"W	1925
10	Colombia	Antioquia	Belmira	Andean	Paramo	6°40'9.42"N	75°42'3.54"W	2890
11	Colombia	Antioquia	San Rafael	Andean	Andean moist forest	6°18'14.55"N	75° 4'36.77"W	1098
12	Colombia	Antioquia	Farallones de Citara	Andean	Andean moist forest	5°45'45.90"N	76° 1'52.97"W	2300
13	Colombia	Bogota D.C	Doña Juana	Andean	Urban	4°31'27.20"N	74° 7'36.00"W	2793
14	Colombia	Bogota D.C	UNAL-Bog	Andean	Urban	4º38´31.71´´ N	74º04´54.02´´W	2560
15	Colombia	Magdalena	Bonga	Caribbean	Tropical Dry forest	11°14'9.80"N	74° 4'17.00"W	259
16	Colombia	Magdalena	Minca	Caribbean	Premontane moist forest	11° 7'57.20"N	74° 7'7.80"W	660
17	Colombia	Magdalena	Cincinati	Caribbean	Montane wet forest	11° 6'6.80"N	74° 4'52.30"W	1430
18	Colombia	Meta	San Martin Forest	Orinoquia	Savanna forest remnant	3°31'59.16"N	73°23'18.96"W	244
19	Colombia	Casanare	Pore Forest	Orinoquia	Savanna forest remnant	5°34'13.49"N	71°54'40.85"W	205
20	Colombia	Meta	Pto Gaitan	Orinoquia	Savanna forest remnant	4°20'33.26"N	72° 4'52.48"W	150
21	Colombia	Chocó	Huina Village	Pacific	Choco rain forest - village	6°16'18.12"N	77°27'33.84"W	10
22	Ecuador	Orellana	Yasuni	Amazon	Tropical rain forest	0°40'27.08"S	76°23'48.98"W	217
23	Ecuador	Quito D.M	Quito	Andean	Urban	0°11'27.07"S	78°30'1.16"W	2850
24	Ecuador	Quito D.M	Quito Rural /Amanguaña	Andean	Rural	0°22'46.58"S	78°29'42.53"W	2597
25	Ecuador	Napo	Papallacta	Andean	Paramo	0°22'23.24"S	78° 8'22.35"W	3390
26	Ecuador	Napo	Narupa	Andean	Andean moist forest	0°43'38.52"S	77°46'22.14"W	1240
27	Ecuador	Santo Domingo	Otongachi	Andean	Andean moist forest	0°18'51.32"S	78°57'1.39"W	889
28	Ecuador	Zamora-Chinchipe	P.N Podocarpus-1	Andean	Andean wet forest	4°19'23.43"S	78°58'52.44"W	2334
29	Ecuador	Zamora-Chinchipe	P.N Podocarpus-2	Andean	Andean wet forest	4° 6'10.04"S	78°56'56.11"W	910
30	Ecuador	Napo	Antisana	Andean	Paramo	0°27'6.91"S	78° 7'20.48"W	4047
31	Ecuador	Napo	Via Muyuna 1	Andean	Foothill Andean forest	0°55'51.94"S	77°52'50.51"W	700
32	Perú	Pasco	Oaxapampa/Bosque San Matias y San Carlos	Andean	Andean moist forest	10°30'43.43"S	75° 4'20.60"W	586
33	Perú	Junin	La Merced	Andean	Andean moist forest	11° 6'0.33"S	75°20'47.50"W	1010
34	Venezuela	Caracas D.C	Sabana Grande	Central range	Urban	10°29'43.06"N	66°52'36.12"W	880
35	Brazil	Brasilia D.F	Brasilia	-	-	15°55'24.33"S	47°52'37.13"W	1080
36	Brazil	Sao Paulo	Santo Andre	-	-	23°43'46.35"S	46°28'7.66"W	800
37	Brazil	Sao Paulo	Botucatu	-	-	22°53'35.92"S	48°25'50.10"W	840
38	Brasil	Sao Paulo	Peruibe	-	-	24°18'1.97"S	46°59'25.95"W	11
39	Brasil	Sao Paulo	Bertioga	-	-	23°48'12.20"S	46° 3'5.33"W	15

Table 1. (Continuation) Geographical and ecological regionalization of sampling localities; m: meters above sea level.

N° locality	Country	Province	Locality Name	Natural region	Coverage	Latitude	Longitude	Elevation (m)
40	Brasil	Rio grande do Sul	Pelotas	-	-	31°46'42.01"S	52°19'13.95"W	10
41	Costa Rica	San Jose	Rohrmoser	-	Urban	9°56'38.96"N	84° 6'45.47"W	1050
42	Costa Rica	Cartago	Taras	-	Urban	9°52'53.07"N	83°55'37.52"W	1455
43	Costa Rica	Alajuela	San Joaquin de Flores	-	-	10° 0'27.90"N	84° 9'35.62"W	1100
44	Mexico	Veracruz	Xalapa	-	-	19°30'35.35"N	96°56'51.09"W	1320
45	Sweden	Skane	Osby	-	Rural	56°24'57.27"N	14° 5'20.78"E	142

Table 2. List of the North West South American blow flies species identified by morphology, number of specimens and their occur localities.

Subfamily	**Genus**	**Species**	**N of specimens**	**Locality number**
Calliphorinae	*Calliphora*	*C. nigribasis*	3	13
		C. vicina	6	13,14
Chrysomyiinae	*Chloroprocta*	*C. idioidea*	8	1,2,4,18,19,21
	Chrysomya	*C. albiceps*	10	4,9,14,16,18
		C. megacephala	9	4,8,14,15,21
		C. putoria	3	2
		C. rufifacies	4	41,42,43
	Cochliomyia	*C. hominivorax*	1	31
		C. macellaria	3	4,9,19
	Compsomyiops	*C. verena*	5	25
	Hemilucilia	*H. benoisti*	4	31,32
		H. segmentaria	2	8
		H. semidiaphana	4	7,18,31
		Hemilucilia sp	1	31
	Paralucilia	*P. fulvinota*	9	2,15,16,31
		P. paraensis	6	2,3,4,31
		P. pseudolyrcea	1	2
		Paralucilia sp.	3	16
Luciliinae	*Blepharicnema*	*B. splendens*	1	12
	Lucilia	*L. albofusca*	2	6,22
		L. caesar	1	45
		L. cuprina	5	8,9,36
		L. eximia	17	3,5,7,9,11,15,20,21,34,35,37,38,39,40,44
		L. ibis	2	24
		L. nitida	3	26,27,28
		L. pulverulenta	4	26
		L. purpuracens	3	7,8,18
		L. sericata	4	13,23
		L. vulgata	1	31
		Lucilia sp1	1	6
		Lucilia sp2	1	26
		Lucilia sp3	1	27
		Lucilia sp4	2	31
		Lucilia sp5	1	33
		Lucilia sp6	1	29
Toxotarsinae	*Sarconesia*	*S. magellanica*	4	10,14
		S. roraima	2	10
		S. splendida	4	30

Table 3. Number of specimens assigned by genus according the Automatic Barcode Gap Definition (ABGD), threshold value of the barcoding gap, groups found and number of correct and incorrect assignments. *mild intra and interspecific overlap among distances; ** intra and interspecific overlap among distances.

				ABGD			
Alignement set by taxon	**N° of sequences**	**Local minima**	**Barcode gap**	**Differentiated groups**	**Prior minimal distance (partition value)**	**Assignment correct**	**Assignment incorrect**
Calliphora	15	2.85	Yes	3	0.001	11	4
Chrysomya	27	3.85	Yes	5	0.004	25	2
Cochliomyia	8	5.86	Yes	2	0.001	8	0
Compsomyiops	6	1.07	Yes	2	0.001	6	0
Hemilucilia	11	3.75	Yes	4	0.001	9	2
Paralucilia	19	2.5	Yes*	2	0.001	19	0
Lucilia	55	2.95	Yes**	16	0.001	5	50
Sarconesia	10	1.67	Yes	4	0.001	8	2

Table 4. Percentage Intra- and interspecific pairwise divergence distances of blow fly species (except Luciliinae) grouped by genus. **ISD:** Intra-specific distance. ($\bar{x}$): Average percentage among all distances of the subordinate taxa.

N	Taxon	ISD	1	2	3
	Genus *Calliphora* ($\bar{x}$=5.72)				
1	*Calliphora nigribasis*	0.00			
2	*Calliphora vicina*	0.00	8.89		
3	*Calliphora vomitoria*	1.29	5.65	5.31	
4	*Calliphora terraenovae*	0.96	6.18	5.49	2.78
	Genus *Chloroprocta*				
1	*Chloroprocta idioidea*	0.81			
	Genus *Chrysomya* ($\bar{x}$=8.94)				
1	*Chrysomya albiceps*	1.92			
2	*Chrysomya megacephala*	0.00	7.09		
3	*Chrysomya putoria*	0.00	8.87	6.70	
4	*Chrysomya rufifacies*	0.00	11.65	9.84	9.50
	Genus *Cochliomyia*				
1	*Cochliomyia hominivorax*	-			
2	*Cochliomyia macellaria*	0.32	10.23		
	Genus *Compsomyiops*				
1	Compsomyiops callipes	-			
2	Compsomyiops verena	0.00	1.93		
	Genus Hemilucilia ($\bar{x}$=8.59)				
1	*Hemilucilia benoisti*	0.00			
2	*Hemilucilia segmentaria*	1.61	9.38		
3	*Hemilucilia semidiaphana*	1.96	7.77	11.93	
4	*Hemilucilia* sp	-	8.48	11.21	2.79
	Genus Paralucilia				
1	*Paralucilia fulvinota*	0.32			
2	*Paralucilia paraensis*	0.21	4.52		
3	*Paralucilia pseudolyrcea*	-	4.40	0.1	
4	*Paralucilia* sp	0.50	0.60	4.9	4.8
	Genus *Sarconesia* ($\bar{x}$=5.52)				
1	*Sarconesia magellanica*	1.95			
2	*Sarconesia roraima*	0.00	4.78		
3	*Sarconesia splendida*	0.16	6.56	5.23	

Table 5. Percentage Intra- and interspecific pairwise divergence distances of blow fly species of Luciliini. **ISD:** Intra-specific distance. Intra-specific distance. ($\overline{x}$): Average percentage among all distances of the subordinate taxa.

N	Taxon	ISD	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
	Tribe Luciliini ($\overline{x}$=7.42)																			
	Genus *Lucilia* ($\overline{x}$=7.15)																			
1	*Lucilia albofusca*	2.59																		
2	*Lucilia caesar*	-	13.60																	
3	*Lucilia cuprina*	0.15	11.43	8.24																
4	*Lucilia eximia*	3.04	3.22	12.53	11.20															
5	*Lucilia ibis*	0.64	4.63	13.00	9.99	4.70														
6	*Lucilia illustris*	0.64	13.40	2.60	9.01	12.42	12.63													
7	*Lucilia nitida*	0.43	1.51	13.13	11.13	2.46	4.19	13.16												
8	*Lucilia pulverulenta*	0.16	1.37	13.30	11.22	2.38	4.05	13.33	0.24											
9	*Lucilia purpurascens*	0.86	4.52	11.69	9.13	4.54	1.94	11.20	4.43	4.28										
10	*Lucilia sericata*	0.11	11.71	7.84	1.11	11.10	10.96	8.48	11.34	11.44	10.08									
11	*Lucilia vulgata*	-	1.94	12.60	11.90	1.98	4.66	12.63	0.85	0.72	4.89	11.34								
12	Lucilia sp	-	13.25	12.10	10.73	11.50	11.91	12.12	12.48	12.58	12.48	10.19	11.71							
13	*Lucilia* sp 1	-	7.48	9.53	8.88	6.69	5.71	8.81	7.52	7.62	4.65	9.83	7.52	11.33						
14	*Lucilia* sp 2	-	1.29	13.40	11.12	2.30	3.96	13.43	0.21	0.08	4.20	11.34	0.64	12.48	7.52					
15	*Lucilia* sp 3	-	1.62	13.80	10.74	2.42	3.96	13.03	0.53	0.40	4.08	10.96	0.96	12.10	7.16	0.32				
16	*Lucilia* sp 4	0.96	1.62	13.60	11.32	2.68	4.48	13.23	0.59	0.48	4.37	11.54	1.12	13.07	7.71	0.48	0.80			
17	*Lucilia* sp 5	-	1.94	14.62	11.51	3.06	5.01	13.83	1.18	1.04	4.54	11.73	1.61	13.66	7.89	0.96	1.29	1.13		
18	*Lucilia* sp 6	-	1.62	13.00	11.51	2.63	4.31	13.03	0.32	0.24	4.54	11.73	0.96	12.87	7.89	0.32	0.64	0.48	1.29	
	Genus *Blepharicnema* ($\overline{x}$=9.74)																			
19	*Blepharicnema splendens*	-	10.28	9.97	9.30	9.55	9.55	9.24	9.93	10.02	9.68	9.51	9.92	10.59	7.72	9.92	9.55	10.12	10.30	10.30

Supplementary material

Table 1. Detailed information of specimens included in the molecular analysis. Labels on tree, pre and post assessment designated taxon, Bold number process ID and Number of GenBank Access, repository and collection date. Localities are in the Figure 1. N. A: not available.

N°	Sample ID	pre-assesement assigned taxon	Post-assesement assigned taxon (Tree-based approach)	Post-assesement assigned taxon (Distance approach)	BOLD Process ID	GenBank Access N	Locality N	Specimen repository	Collection date
1	COL13|002|Calliphora nigribasis	*Calliphora nigribasis*	*Calliphora nigribasis*	*Calliphora nigribasis*	CFBI001-17	MH033970	13	CETdeA	ii-v-2013
2	COL13|003|Calliphora nigribasis	*Calliphora nigribasis*	*Calliphora nigribasis*	*Calliphora nigribasis*	CFBI002-17	MH033971	13	CETdeA	ii-v-2013
3	COL13|004|Calliphora nigribasis	*Calliphora nigribasis*	*Calliphora nigribasis*	*Calliphora nigribasis*	CFBI003-17	MH033968	13	CETdeA	ii-v-2013
4	COL14|005|Calliphora vicina	*Calliphora vicina*	*Calliphora vicina*	*Calliphora vicina*	CFBI004-17	n.a	14	CETdeA	30.iii.2014
5	COL14|006|Calliphora vicina	*Calliphora vicina*	*Calliphora vicina*	*Calliphora vicina*	CFBI005-17	MH033975	14	CETdeA	30.iii.2014
6	COL13|013|Calliphora vicina	*Calliphora vicina*	*Calliphora vicina*	*Calliphora vicina*	CFBI009-17	MH033977	13	CETdeA	ii-v-2013
7	COL14|014|Calliphora vicina	*Calliphora vicina*	*Calliphora vicina*	*Calliphora vicina*	CFBI010-17	MH033976	14	CETdeA	30.iii.2014
8	COL14|015|Calliphora vicina	*Calliphora vicina*	*Calliphora vicina*	*Calliphora vicina*	CFBI011-17	MH033974	14	CETdeA	30.iii.2014
9	COL14|016|Calliphora vicina	*Calliphora vicina*	*Calliphora vicina*	*Calliphora vicina*	CFBI012-17	MH033973	14	CETdeA	30.iii.2014
10	GenBank|KF030471.1	*Calliphora vicina*	*Calliphora vicina*	*Calliphora vicina*	n.a	KF030471.1	-	n.a	n.a
11	GenBank-KOR|EU880192.1	*Calliphora vicina*	*Calliphora vicina*	*Calliphora vicina*	n.a	EU880192.1	-	n.a	n.a
12	GenBank|KF030471.1	*Calliphora vicina*	*Calliphora vicina*	*Calliphora vicina*	n.a	KF030471.1	-	n.a	n.a
13	GenBank-USA|FR719156.1	*Calliphora vomitoria*	*Calliphora vomitoria*	Uncertain	n.a	FR719156.1	-	n.a	n.a
14	GenBank-USA|KF030469.1	*Calliphora vomitoria*	*Calliphora vomitoria*	Uncertain	n.a	KF030469.1	-	n.a	n.a
15	GenBank|JQ806886.1	*Calliphora terraenovae*	*Calliphora terraenovae*	Uncertain	n.a	JQ806886.1	-	n.a	n.a
16	GenBank-USA|KF030470.1	*Calliphora terraenovae*	*Calliphora terraenovae*	Uncertain	n.a	KF030470.1	-	n.a	n.a
17	BRA2|149|Chloroprocta idioidea	*Chloroprocta idioidea*	*Chloroprocta idioidea*	*Chloroprocta idioidea*	CFBI060-17	MH033985	2	INPA	18.vii.2014
18	COL4|178|Chloroprocta idioidea	*Chloroprocta idioidea*	*Chloroprocta idioidea*	*Chloroprocta idioidea*	CFBI069-17	MH033983	4	CETdeA	20.v.2016
19	COL19|179|Chloroprocta idioidea	*Chloroprocta idioidea*	*Chloroprocta idioidea*	*Chloroprocta idioidea*	CFBI070-17	MH033982	19	CETdeA	20.v.2016
20	COL4|180|Chloroprocta idioidea	*Chloroprocta idioidea*	*Chloroprocta idioidea*	*Chloroprocta idioidea*	CFBI071-17	MH033981	4	CETdeA	25.ix.2013
21	COL21|182|Chloroprocta idioidea	*Chloroprocta idioidea*	*Chloroprocta idioidea*	*Chloroprocta idioidea*	CFBI072-17	MH033980	21	CETdeA	25.ix.2013
22	COL18|221|Chloroprocta idioidea	*Chloroprocta idioidea*	*Chloroprocta idioidea*	*Chloroprocta idioidea*	CFBI095-17	MH033984	18	CETdeA	6.vi.2013
23	BRA1|289|Chloroprocta idioidea	*Chloroprocta idioidea*	*Chloroprocta idioidea*	*Chloroprocta idioidea*	CFBI151-17	MH033979	1	INPA	3.xii.2013
24	BRA1|290|Chloroprocta idioidea	*Chloroprocta idioidea*	*Chloroprocta idioidea*	*Chloroprocta idioidea*	CFBI152-17	MH033978	1	INPA	3.xii.2013
25	COL16|263|Chrysomya albiceps	*Chrysomya albiceps*	*Chrysomya albiceps*	Uncertain	CFBI130-17	MH033987	16	CETdeA	2.iii.2013
26	COL16|264|Chrysomya albiceps	*Chrysomya albiceps*	*Chrysomya albiceps*	*Chrysomya albiceps*	CFBI131-17	MH033996	16	CETdeA	2.iii.2013
27	COL18|265|Chrysomya albiceps	*Chrysomya albiceps*	*Chrysomya albiceps*	*Chrysomya albiceps*	CFBI132-17	MH033995	18	CETdeA	6.vi.2013

28	COL18|266|Chrysomya albiceps	*Chrysomya albiceps*	*Chrysomya albiceps*	Uncertain	CFBI133-17	MH033994	18	CETdeA	6.vi.2013
29	COL4|267|Chrysomya albiceps	*Chrysomya albiceps*	*Chrysomya albiceps*	*Chrysomya albiceps*	CFBI134-17	MH033993	4	CETdeA	27.xii.2013
30	COL4|268|Chrysomya albiceps	*Chrysomya albiceps*	*Chrysomya albiceps*	*Chrysomya albiceps*	CFBI135-17	MH033992	4	CETdeA	27.xii.2013
31	COL14|269|Chrysomya albiceps	*Chrysomya albiceps*	*Chrysomya albiceps*	*Chrysomya albiceps*	CFBI136-17	MH033991	14	CETdeA	09-12.v.2014
32	COL14|270|Chrysomya albiceps	*Chrysomya albiceps*	*Chrysomya albiceps*	*Chrysomya albiceps*	CFBI137-17	MH033990	14	CETdeA	09-12.v.2014
33	COL9|271|Chrysomya albiceps	*Chrysomya albiceps*	*Chrysomya albiceps*	*Chrysomya albiceps*	CFBI138-17	MH033989	9	CETdeA	24.x.2012
34	COL9|272|Chrysomya albiceps	*Chrysomya albiceps*	*Chrysomya albiceps*	*Chrysomya albiceps*	CFBI139-17	MH033988	9	CETdeA	24.x.2012
35	COL15|273|Chrysomya megacephala	*Chrysomya megacephala*	*Chrysomya megacephala*	*Chrysomya megacephala*	CFBI140-17	MH033998	15	CETdeA	3.iii.2013
36	COL15|274|Chrysomya megacephala	*Chrysomya megacephala*	*Chrysomya megacephala*	*Chrysomya megacephala*	CFBI141-17	MH033999	15	CETdeA	3.iii.2013
37	COL21|275|Chrysomya megacephala	*Chrysomya megacephala*	*Chrysomya megacephala*	*Chrysomya megacephala*	CFBI142-17	MH034000	21	CETdeA	25.ix.2013
38	COL21|276|Chrysomya megacephala	*Chrysomya megacephala*	*Chrysomya megacephala*	*Chrysomya megacephala*	CFBI143-17	MH034001	21	CETdeA	25.ix.2013
39	COL4|277|Chrysomya megacephala	*Chrysomya megacephala*	*Chrysomya megacephala*	*Chrysomya megacephala*	CFBI144-17	MH034002	4	CETdeA	24.xii.2013
40	COL4|278|Chrysomya megacephala	*Chrysomya megacephala*	*Chrysomya megacephala*	*Chrysomya megacephala*	CFBI145-17	MH034003	4	CETdeA	24.xii.2013
41	COL14|279|Chrysomya megacephala	*Chrysomya megacephala*	*Chrysomya megacephala*	*Chrysomya megacephala*	CFBI146-17	MH033997	14	CETdeA	25-28-viii.2014
42	COL14|280|Chrysomya megacephala	*Chrysomya megacephala*	*Chrysomya megacephala*	*Chrysomya megacephala*	CFBI147-17	MH033997	14	CETdeA	25-28-viii.2014
43	COL8|281|Chrysomya megacephala	*Chrysomya megacephala*	*Chrysomya megacephala*	*Chrysomya megacephala*	CFBI148-17	MH034005	8	CETdeA	26.ix.2012
44	BRA2|140|Chrysomya putoria	*Chrysomya putoria*	*Chrysomya putoria*	*Chrysomya putoria*	CFBI055-17	MH034007	2	INPA	18.vii.2014
45	BRA2|141|Chrysomya putoria	*Chrysomya putoria*	*Chrysomya putoria*	*Chrysomya putoria*	CFBI056-17	MH034006	2	INPA	18.vii.2014
46	BRA2|142|Chrysomya putoria	*Chrysomya putoria*	*Chrysomya putoria*	*Chrysomya putoria*	CFBI057-17	n.a	2	INPA	18.vii.2014
47	GenBank-BRA|AF352790	*Chrysomya putoria*	*Chrysomya putoria*	*Chrysomya putoria*	n.a	AF352790	n.a.	n.a	n.a
48	CR42|229|Chrysomya rufifacies	*Chrysomya rufifacies*	*Chrysomya rufifacies*	*Chrysomya rufifacies*	CFBI101-17	MH034010	42	CETdeA	xii.2008
49	CR43|230|Chrysomya rufifacies	*Chrysomya rufifacies*	*Chrysomya rufifacies*	*Chrysomya rufifacies*	CFBI102-17	MH034009	43	CETdeA	i.1999
50	CR41|231|Chrysomya rufifacies	*Chrysomya rufifacies*	*Chrysomya rufifacies*	*Chrysomya rufifacies*	CFBI103-17	MH034011	41	CETdeA	Vii.1998
51	CR42|232|Chrysomya rufifacies	*Chrysomya rufifacies*	*Chrysomya rufifacies*	*Chrysomya rufifacies*	CFBI104-17	MH034008	42	CETdeA	xii.2008
52	GenBank-BRA-AF260826	*Cochliomyia hominivorax*	*Cochliomyia hominivorax*	*Cochliomyia hominivorax*	n.a	AF260826	SP,Brazil	n.a	n.a
53	GenBank-BRA-NC002660	*Cochliomyia hominivorax*	*Cochliomyia hominivorax*	*Cochliomyia hominivorax*	n.a	NC002660	SP,Brazil	n.a	n.a
54	ECU31|253|Cochliomyia hominivorax	*Cochliomyia hominivorax*	*Cochliomyia hominivorax*	*Cochliomyia hominivorax*	CFBI122-17	MH034012	31	CETdeA	04.vii.2016
55	COL19|173|Cochliomyia macellaria	*Cochliomyia macellaria*	*Cochliomyia macellaria*	*Cochliomyia macellaria*	CFBI066-17	MH034013	19	CETdeA	20.v.2016
56	COL9|174|Cochliomyia macellaria	*Cochliomyia macellaria*	*Cochliomyia macellaria*	*Cochliomyia macellaria*	CFBI067-17	MH034015	9	CETdeA	25.ii.2011
57	COL4|175|Cochliomyia macellaria	*Cochliomyia macellaria*	*Cochliomyia macellaria*	*Cochliomyia macellaria*	CFBI068-17	MH034014	4	CETdeA	27.xii.2013
58	GenBank-USA|AF295555.1	*Cochliomyia macellaria*	*Cochliomyia macellaria*	*Cochliomyia macellaria*	n.a	AF295555.1	-	n.a	n.a
59	GenBank-USA|KF030473.1	*Cochliomyia macellaria*	*Cochliomyia macellaria*	*Cochliomyia macellaria*	n.a	KF030473.1	-	n.a	n.a
60	GenBank|KF030479.1	*Compsomyiops callipes*	*Compsomyiops callipes*	*Compsomyiops callipes*	n.a	KF030479.1	-	n.a	n.a
61	ECU25|195|Compsomyiops verena	*Compsomyiops verena*	*Compsomyiops verena*	*Compsomyiops verena*	CFBI078-17	MH034020	25	QCAZ	10/31/2015

62	ECU25|196|Compsomyiops verena	*Compsomyiops verena*	*Compsomyiops verena*	*Compsomyiops verena*	CFBI079-17	MH034019	25	QCAZ	10/31/2015
63	ECU25|197|Compsomyiops verena	*Compsomyiops verena*	*Compsomyiops verena*	*Compsomyiops verena*	CFBI080-17	MH034018	25	QCAZ	10/31/2015
64	ECU25|260|Compsomyiops verena	*Compsomyiops verena*	*Compsomyiops verena*	*Compsomyiops verena*	CFBI128-17	MH034017	25	CETdeA	x.2015
65	ECU25|262|Compsomyiops verena	*Compsomyiops verena*	*Compsomyiops verena*	*Compsomyiops verena*	CFBI129-17	MH034016	25	CETdeA	x.2015
66	ECU31|246|Hemilucilia benoisti	*Hemilucilia benoisti*	*Hemilucilia benoisti*	*Hemilucilia benoisti*	CFBI116-17	MH034023	31	CETdeA	03.vii.2016
67	ECU31|247|Hemilucilia benoisti	*Hemilucilia benoisti*	*Hemilucilia benoisti*	*Hemilucilia benoisti*	CFBI117-17	MH034025	31	CETdeA	03.vii.2016
68	PE32|287|Hemilucilia benoisti	*Hemilucilia benoisti*	*Hemilucilia benoisti*	*Hemilucilia benoisti*	CFBI149-17	MH034022	32	MEKRB	3-6.v.2015
69	PE32|288|Hemilucilia benoisti	*Hemilucilia benoisti*	*Hemilucilia benoisti*	*Hemilucilia benoisti*	CFBI150-17	MH034021	32	MEKRB	3-6.v.2015
70	COL8|223|Hemilucilia segmentaria	*Hemilucilia segmentaria*	*Hemilucilia segmentaria*	*Hemilucilia segmentaria*	CFBI096-17	MH034026	8	CETdeA	29.iii.2011
71	COL8|224|Hemilucilia segmentaria	*Hemilucilia segmentaria*	*Hemilucilia segmentaria*	*Hemilucilia segmentaria*	CFBI097-17	MH034027	8	CETdeA	2.iii.2013
72	COL18|228|Hemilucilia semidiaphana	*Hemilucilia semidiaphana*	*Hemilucilia semidiaphana*	*Hemilucilia semidiaphana*	CFBI100-17	n.a	18	CETdeA	6.vi.2013
73	COL18|245|Hemilucilia semidiaphana	*Hemilucilia semidiaphana*	*Hemilucilia semidiaphana*	*Hemilucilia semidiaphana*	CFBI115-17	MH034028	18	CETdeA	6.vi.2013
74	ECU31|250|Hemilucilia semidiaphana	*Hemilucilia semidiaphana*	*Hemilucilia semidiaphana*	*Hemilucilia semidiaphana*	CFBI119-17	MH034031	31	CETdeA	04.vii.2016
75	COL7|252|Hemilucilia semidiaphana	*Hemilucilia semidiaphana*	*Hemilucilia semidiaphana*	Uncertain	CFBI121-17	MH034029	7	CETdeA	29.ii.2012
76	ECU31|251|Hemilucilia sp	*Hemilucilia sp*	*Hemilucilia semidiaphana*	Uncertain	CFBI120-17	MH034030	31	CETdeA	04.vii.2016
77	BRA2|150|Paralucilia fulvinota	*Paralucilia fulvinota*	*Paralucilia fulvinota*	*Paralucilia fulvinota*	CFBI061-17	MH034093	2	INPA	x-xi.2014
78	BRA2|155|Paralucilia fulvinota	*Paralucilia fulvinota*	*Paralucilia fulvinota*	*Paralucilia fulvinota*	CFBI064-17	MH034101	2	INPA	x-xi.2014
79	BRA2|156|Paralucilia fulvinota	*Paralucilia fulvinota*	*Paralucilia fulvinota*	Uncertain	CFBI065-17	MH034102	2	INPA	x-xi.2014
80	COL16|213|Paralucilia fulvinota	*Paralucilia fulvinota*	*Paralucilia fulvinota*	*Paralucilia fulvinota*	CFBI090-17	MH034083	16	CETdeA	2.iii.2013
81	COL16|214|Paralucilia sp.	*Paralucilia sp.*	*Paralucilia fulvinota*	*Paralucilia fulvinota*	CFBI091-17	MH034084	16	CETdeA	2.iii.2013
82	COL16|215|Paralucilia sp.	*Paralucilia sp.*	*Paralucilia fulvinota*	*Paralucilia fulvinota*	CFBI092-17	MH034085	16	CETdeA	2.iii.2013
83	COL15|234|Paralucilia fulvinota	*Paralucilia fulvinota*	*Paralucilia fulvinota*	*Paralucilia fulvinota*	CFBI106-17	MH034087	15	CETdeA	3.iii.2013
84	ECU31|236|Paralucilia fulvinota	*Paralucilia fulvinota*	*Paralucilia fulvinota*	*Paralucilia fulvinota*	CFBI107-17	MH034088	31	CETdeA	03.vii.2016
85	ECU31|237|Paralucilia fulvinota	*Paralucilia fulvinota*	*Paralucilia fulvinota*	*Paralucilia fulvinota*	CFBI108-17	MH034082	31	CETdeA	04.vii.2016
86	COL16|238|Paralucilia sp	*Paralucilia sp.*	*Paralucilia fulvinota*	*Paralucilia fulvinota*	CFBI109-17	MH034089	16	CETdeA	2.iii.2013
87	ECU31|243|Paralucilia fulvinota	*Paralucilia fulvinota*	*Paralucilia fulvinota*	*Paralucilia fulvinota*	CFBI113-17	MH034090	31	CETdeA	04.vii.2016
88	ECU31|244|Paralucilia fulvinota	*Paralucilia fulvinota*	*Paralucilia fulvinota*	*Paralucilia fulvinota*	CFBI114-17	MH034091	31	CETdeA	04.vii.2016
89	BRA2|151|Paralucilia paraensis	*Paralucilia paraensis*	*Paralucilia paraensis*	*Paralucilia paraensis*	CFBI062-17	MH034095	2	INPA	x-xi.2014
90	COL3|218|Paralucilia paraensis	*Paralucilia paraensis*	*Paralucilia paraensis*	*Paralucilia paraensis*	CFBI093-17	MH034097	3	CETdeA	24.xi.2013
91	COL3|219|Paralucilia paraensis	*Paralucilia paraensis*	*Paralucilia paraensis*	*Paralucilia paraensis*	CFBI094-17	MH034098	3	CETdeA	24.xi.2013
92	ECU31|240|Paralucilia paraensis	*Paralucilia paraensis*	*Paralucilia paraensis*	*Paralucilia paraensis*	CFBI110-17	MH034094	31	CETdeA	04.vii.2016
93	COL3|241|Paralucilia paraensis	*Paralucilia paraensis*	*Paralucilia paraensis*	*Paralucilia paraensis*	CFBI111-17	MH034099	3	CETdeA	24.xi.2013
94	COL3|242|Paralucilia paraensis	*Paralucilia paraensis*	*Paralucilia paraensis*	*Paralucilia paraensis*	CFBI112-17	MH034100	4	CETdeA	24.xi.2013
95	BRA2|152|Paralucilia pseudolyrcea	*Paralucilia pseudolyrcea*	*Paralucilia paraensis*	*Paralucilia paraensis*	CFBI063-17	MH034096	2	INPA	x-xi.2014
96	ECU22|084|Lucilia albofusca	*Lucilia albofusca*	Uncertain	Uncertain	CFBI031-17	MH034035	22	QCAZ	6.iv.2012

97	COL6|293|Lucilia albofusca	*Lucilia albofusca*	Uncertain	Uncertain	CFBI153-17	MH034034	6	IAvH	20.i-1.ii.2003
98	SWE45|050|Lucilia caesar	*Lucilia caesar*	Uncertain	Uncertain	CFBI025-17	MH034036	45	CETdeA	2-5.vii.2011
99	COL8|017|Lucilia cuprina	*Lucilia cuprina*	*Lucilia cuprina*	Uncertain	CFBI013-17	MH034040	8	CETdeA	12.iii.2010
100	COL8|021|Lucilia cuprina	*Lucilia cuprina*	*Lucilia cuprina*	Uncertain	CFBI015-17	MH034038	8	CETdeA	vi.2015
101	COL8|022|Lucilia cuprina	*Lucilia cuprina*	*Lucilia cuprina*	Uncertain	CFBI016-17	MH034039	8	CETdeA	vi.2015
102	COL9|026|Lucilia cuprina	*Lucilia cuprina*	*Lucilia cuprina*	Uncertain	CFBI017-17	MH034041	9	CETdeA	vi.2015
103	BRA36|121|Lucilia cuprina	*Lucilia cuprina*	*Lucilia cuprina*	Uncertain	CFBI045-17	MH034037	36	UNICAMP	20.XII.2012
104	GenBank-Thailand|EF472503.1	*Lucilia cuprina*	*Lucilia cuprina*	Uncertain	n.a	EF472503.1	-	n.a	n.a
105	GenBank-USA|KF030477.1	*Lucilia cuprina*	*Lucilia cuprina*	Uncertain	n.a	KF030477.1	-	n.a	n.a
106	VEN34|054|Lucilia eximia	*Lucilia eximia*	Uncertain	Uncertain	CFBI026-17	MH034053	34	MIZA	29.x.1949
107	VEN34|055|Lucilia eximia	*Lucilia eximia*	Uncertain	Uncertain	n.a	n.a	34	MIZA	11.x.1985
108	COL11|067|Lucilia eximia	*Lucilia eximia*	Uncertain	Uncertain	CFBI027-17	MH034052	11	CETdeA	09.ix.2014
109	COL5|114|Lucilia eximia	*Lucilia eximia*	Uncertain	Uncertain	CFBI041-17	MH034048	5	CETdeA	4.v.2015
110	MEX44|116|Lucilia eximia	*Lucilia eximia*	Uncertain	Uncertain	CFBI042-17	MH034049	44	CETdeA	25.viii.2014
111	COL15|118|Lucilia eximia	*Lucilia eximia*	Uncertain	Uncertain	CFBI043-17	MH034050	15	CETdeA	3.iii.2013
112	BRA35|120|Lucilia eximia	*Lucilia eximia*	Uncertain	Uncertain	CFBI044-17	MH034051	35	UNICAMP	15.X.2009
113	BRA37|124|Lucilia eximia	*Lucilia eximia*	Uncertain	Uncertain	CFBI046-17	MH034054	37	UNICAMP	14.III.2012
114	BRA38|125|Lucilia eximia	*Lucilia eximia*	Uncertain	Uncertain	n.a	n.a	38	UNICAMP	01.XI.2011
115	BRA39|128|Lucilia eximia	*Lucilia eximia*	Uncertain	Uncertain	CFBI047-17	MH034055	39	UNICAMP	18.I.2013
116	BRA36|129|Lucilia eximia	*Lucilia eximia*	Uncertain	Uncertain	CFBI048-17	MH034055	36	UNICAMP	26.IV.2013
117	BRA40|130|Lucilia eximia	*Lucilia eximia*	Uncertain	Uncertain	CFBI049-17	MH034043	40	UNICAMP	03.XI.2011
118	COL3|132|Lucilia_eximia	*Lucilia eximia*	Uncertain	Uncertain	CFBI050-17	MH034045	3	CETdeA	22.xi.2013
119	COL7|134|Lucilia eximia	*Lucilia eximia*	Uncertain	Uncertain	n.a	n.a	7	CETdeA	7.vii.2010
120	COL9|135|Lucilia eximia	*Lucilia eximia*	Uncertain	Uncertain	CFBI051-17	MH034044	9	CETdeA	6.x.2010
121	COL21|136|Lucilia eximia	*Lucilia eximia*	Uncertain	Uncertain	CFBI052-17	MH034047	21	CETdeA	25.ix.2013
122	COL20|137|Lucilia eximia	*Lucilia eximia*	Uncertain	Uncertain	CFBI053-17	MH034046	20	CETdeA	n.a
123	ECU24|205|Lucilia ibis	*Lucilia ibis*	*Lucilia ibis*	*Lucilia ibis*	CFBI082-17	MH034057	24	QCAZ	29.vi.2016
124	ECU24|206|Lucilia ibis	*Lucilia ibis*	*Lucilia ibis*	*Lucilia ibis*	CFBI083-17	MH034056	24	QCAZ	29.vi.2016
125	GenBank-USA|JQ942420.1	*Lucilia illustris*	Uncertain	*Lucilia illustris*	n.a	JQ942420.1	-	n.a	n.a
126	GenBank-USA|KF921622.1	*Lucilia illustris*	Uncertain	*Lucilia illustris*	n.a	KF921622.1	-	n.a	n.a
127	ECU26|074|Lucilia nitida	*Lucilia nitida*	Uncertain	Uncertain	CFBI029-17	MH034015	26	CETdeA	5-7.v.2015
128	ECU27|085|Lucilia nitida	*Lucilia nitida*	Uncertain	Uncertain	CFBI032-17	MH034060	27	QCAZ	10.vii.2014
129	ECU28|255|Lucilia nitida	*Lucilia nitida*	*Lucilia sp*	Uncertain	CFBI124-17	MH034061	28	CETdeA	20-23.vi.2016
130	ECU26|103|Lucilia pulverulenta	*Lucilia pulverulenta*	*Lucilia sp*	Uncertain	CFBI037-17	MH034065	26	CETdeA	7.iv.2015
131	ECU26|104|Lucilia pulverulenta	*Lucilia pulverulenta*	*Lucilia sp*	Uncertain	CFBI038-17	MH034064	26	CETdeA	7.iv.2015

132	ECU26|105|Lucilia pulverulenta	*Lucilia pulverulenta*	*Lucilia sp*	Uncertain	CFBI039-17	MH034062	26	CETdeA	7.iv.2015
133	ECU26|106|Lucilia pulverulenta	*Lucilia pulverulenta*	*Lucilia sp*	Uncertain	CFBI040-17	MH034063	26	CETdeA	7.iv.2015
134	COL7|030|Lucilia purpurascens	uncertain	*Lucilia purpurascens*	*Lucilia purpurascens*	CFBI018-17	MH034068	7	CETdeA	2.iii.2013
135	COL17|033|Lucilia purpurascens	*Lucilia purpurascens*	*Lucilia purpurascens*	*Uncertain*	CFBI019-17	MH034069	17	CETdeA	2.iii.2013
136	COL8|034|Lucilia purpurascens	*Lucilia purpurascens*	*Lucilia purpurascens*	*Lucilia purpurascens*	CFBI020-17	MH034066	8	CETdeA	23.ii.2011
137	COL13|037|Lucilia sericata	*Lucilia sericata*	*Lucilia sericata*	Uncertain	CFBI021-17	MH034071	13	CETdeA	ii-v-2013
138	COL13|038|Lucilia sericata	*Lucilia sericata*	*Lucilia sericata*	Uncertain	CFBI022-17	MH034072	13	CETdeA	ii-v-2013
139	COL13|042|Lucilia sericata	*Lucilia sericata*	*Lucilia sericata*	Uncertain	CFBI023-17	MH034070	13	CETdeA	ii-v-2013
140	ECU23|202|Lucilia sericata	*Lucilia sericata*	*Lucilia sericata*	Uncertain	CFBI081-17	MH034073	23	QCAZ	5.vii.2016
141	GenBank-UK|AJ422212	*Lucilia sericata*	*Lucilia sericata*	Uncertain	n.a	AJ422212	-	n.a	n.a
142	GenBank-USA|JX913757.1	*Lucilia sericata*	*Lucilia sericata*	Uncertain	n.a	JX913757.1	-	n.a	n.a
143	ECU31|254|Lucilia vulgata	*Lucilia vulgata*	Uncertain	Uncertain	CFBI123-17	MH034081	31	CETdeA	04.vii.2016
144	COL6|294|Lucilia sp.1	*Lucilia* sp1	Uncertain	Uncertain	CFBI154-17	MH034074	6	IAvH	20.i-1.ii.2003
145	ECU26|100|Lucilia sp.2	*Lucilia* sp2	Uncertain	Uncertain	CFBI036-17	MH034075	26	CETdeA	5-7.iv.2015
146	ECU27|090|Lucilia sp.3	*Lucilia* sp3	Uncertain	Uncertain	CFBI033-17	MH034077	27	QCAZ	08.vii.2014
147	ECU31|256|Lucilia sp.4	*Lucilia* sp4	Uncertain	Uncertain	CFBI125-17	MH034080	31	CETdeA	04.vii.2016
148	ECU31|257|Lucilia sp.4	*Lucilia* sp4	Uncertain	Uncertain	CFBI126-17	MH034079	31	CETdeA	04.vii.2016
149	PE33|097|Lucilia sp.5	*Lucilia* sp5	Uncertain	Uncertain	CFBI035-17	MH034076	33	UNMSM	21.ii.2009
150	ECU29|259|Lucilia sp6	*Lucilia* sp6	Uncertain	Uncertain	CFBI127-17	MH034078	29	CETdeA	20-23.vi.2016
151	COL12|008|Blepharicnema splendens	*Blepharicnema splendens*	-	-	CFBI007-17	MH033966	12	CETdeA	21.iii.2009
152	ECU30|191|Sarconesia splendida	*Sarconesia splendida*	*Sarconesia splendida*	*Sarconesia splendida*	CFBI074-17	MH034112	30	QCAZ	xii.2015
153	ECU30|192|Sarconesia splendida	*Sarconesia splendida*	*Sarconesia splendida*	*Sarconesia splendida*	CFBI075-17	MH034109	30	QCAZ	xii.2015
154	ECU30|193|Sarconesia splendida	*Sarconesia splendida*	*Sarconesia splendida*	*Sarconesia splendida*	CFBI076-17	MH034111	30	QCAZ	xii.2015
155	ECU30|194|Sarconesia splendida	*Sarconesia splendida*	*Sarconesia splendida*	*Sarconesia splendida*	CFBI077-17	MH034110	30	QCAZ	xii.2015
156	COL10|211|Sarconesia roraima	*Sarconesia roraima*	*Sarconesia roraima*	*Sarconesia roraima*	CFBI088-17	MH034107	10	CETdeA	15-20.xii.2012
157	COL10|212|Sarconesia roraima	*Sarconesia roraima*	*Sarconesia roraima*	*Sarconesia roraima*	CFBI089-17	MH034108	10	CETdeA	15-20.xii.2012
158	COL14|207|Sarconesia magellanica	*Sarconesia magellanica*	*Sarconesia magellanica*	Uncertain	CFBI084-17	MH034106	14	CETdeA	25-28-viii.2014
159	COL14|208|Sarconesia magellanica	*Sarconesia magellanica*	*Sarconesia magellanica*	Uncertain	CFBI085-17	MH034103	14	CETdeA	25-28-viii.2014
160	COL10|209|Sarconesia magellanica	*Sarconesia magellanica*	*Sarconesia magellanica*	Uncertain	CFBI086-17	MH034104	10	CETdeA	22x.2013
161	COL10|210|Sarconesia magellanica	*Sarconesia magellanica*	*Sarconesia magellanica*	Uncertain	CFBI087-17	MH034105	10	CETdeA	22x.2013
162	GenBank|DMU3754	*Drosophila melanogaster*	*Drosophila melanogaster*	Uncertain	n.a	DMU3754	-	n.a	n.a

SÍNTESE

Atualmente, a fauna de Calliphoridae (s.s) do Noroeste da América do Sul compreende um conjunto de 33 espécies (incluindo uma espécie nova de *Lucilia* da Amazônia), agrupadas em 4 subfamílias e 10 gêneros. A diversidade por área foi consideravelmente alta (54%) quando comparada ao número total de espécies neotropicais (atualmente 61 spp.). Portanto, consideramos o Noroeste da América do Sul como uma área importante na diversificação de Califorídeos neotropicais. A atual fauna de Calliphoridae nesta região é composta por três componentes de diferentes origens biogeográficas; o primeiro inclui as espécies neotropicais, o segundo as espécies temperadas de origem austral e o ultimo inclui as espécies exóticas, seja as introduzidas ou com distribuição cosmopolita. É possível também categorizar as espécies de Calliphoridae no Noroeste da América do Sul segundo a distribuição altitudinal. Assim, existem espécies de terras baixas, de montanha e de altas elevações, sendo o mais diverso aquele grupo composto pelas espécies de montanha (Tabla 3, capitulo 4). Se descarta a atual ocorrência de *Chrysomya rufifacies* e *Compsomyiops melloi* no Noroeste da América do Sul.

O noroeste de américa do Sul pode ser dividido preliminarmente em 6 regiões naturais para entender a distribuição da fauna de moscas: duas regiões elevadas (região Andina e Tepuiana) e quatro regiões de terras baixas (Amazônia, Orinoquia, Caribe e Pacífica). A região Andina possui a maior diversidade de Calliphoridae (30 spp.), seguida pela região Caribe (17 spp.), Amazônia (14 spp.) e Pacífica (10 spp.); as regiões com o menor número de espécies são a Orinoquia (9 spp.) e a região Tepuiana (6 spp.). A diversidade local das assembleias de Calliphoridae (s.s) nas três localidades avaliadas foram de 6 espécies para o ecossistema de Páramo; 9 espécies no interflúvio amazônico e 12 espécies para os habitats da Sierra Nevada de Santa Marta. Foi demonstrado que os rios amazônicos não influenciam a composição da assembleias locais de Calliphoridae, consequentemente, eles não representam uma barreira na dispersão das espécies. As assembleias de Calliphoridae no ecossistema de Páramo são pouco diversas e pobres em espécies, condição ecológica que pode ser o resultado de duas possíveis causas: a lenta velocidade de colonização de habitat e um baixo número de espécies desenvolvendo seu nicho neste ambiente recém formado geologicamente. Possivelmente, os 3-5 milhões de anos depois do surgimento dos Andes não foram tempo suficiente para que os califorídeos preenchessem os nichos ecológicos disponíveis neste frio e inóspito ecossistema

(Amat *et al.* In press). Igualmente, não foi evidenciada sazonalidade nas espécies do páramo durante os dois anos de monitoramento. A presença quase uniforme das espécies e sua diversidade nos distintos aspectos (abundancia e dominância) pode ser explicada pelos permanentes fatores climáticos extremos, como a temperatura e humidade constante durante todo o ano, embora a temperatura seja marcadamente variável na flutuação diária entre 11-25°C (Hofstede *et al.* 2003). Estes valores de riqueza local junto com a informação geográfica obtida dos museus entomológicos demostra que o ambiente com gradiente altitudinal acolhe um maior número de espécies de Calliphoridae. Os dados obtidos são enviesados devido o esforço de amostragem por região ter se concentrado na proximidade dos centros urbanos (Bogotá, Caracas, Quito e Manaus, entre outros) e seus canais de comunicação (estradas, rios, caminhos, etc.).

Foi possível obter sequências de DNA mitocondrial de 317 pares de bases (mini-Barcode) para 30 espécies de Calliphoridae ocorrentes no noroeste da América do Sul. Além disso, foi possível a sua utilização na identificação de espécies de *Calliphora*, *Chrysomya, Cochliomyia*, *Paralucilia*, *Sarconesia* e *Hemilucilia*. Contudo, o uso destas sequências não foi informativo para identificar as espécies de *Lucilia* e mais dados são necessários para identificar as espécies de *Compsomyiops*. Foi possível recuperar estas sequências genéticas de exemplares antigos depositados em coleções por até 57 anos, demostrando uma alta aplicabilidade deste marcador para o seu uso em espécimes de museus preservados durante várias décadas. As atuais chaves taxonômicas para a identificação das espécies de *Compsomyiops*, *Hemilucilia, Paralucilia* não são adequadas para a identificação morfológica das espécies. Assim, recomenda-se avançar nos estudos incluindo dados moleculares de vários marcadores genéticos, por exemplo, 28S, ITS e Cytb, além da morfologia tradicional.

Para contribuir com o conhecimento biogeográfico de Calliphoridae na região são necessários mais estudos com o grupo na região tepuiana, além de um estudo das assembleias de Califorídeos ao longo do gradiente altitudinal na região montanhosa costeira da Venezuela para avaliar a sua afinidade com a fauna da região Andina e reuní-las numa única área. Também, são urgentes estudos nas savanas Colombo-Venezuelanas, na região norte do Peru, na região amazônica do Brasil e Colômbia próxima às fronteiras, nas planícies do Caribe Colombiano e vales inter-andinos e finalmente na região Pacífica da Colômbia e Equador.

Os padrões de diversidade encontrados neste estudo podem ser explicados com base em duas interpretações feitas para entender a diversidade global em gradientes. É altamente possível que a aproximação ecológica e a hipótese histórica e evolutiva (Mittelbach *et al.*, 2007) estejam operando ao mesmo tempo em diferentes magnitudes. A aproximação ecológica inclui a hipótese de heterogeneidade ambiental (Pianka, 1966), a hipótese de distúrbio (Connell, 1978) e a hipótese de riqueza de gradiente altitudinal (Rahbek, 1995). Claramente, a região andina oferece uma maior quantidade de biomas diferentes para abrigar uma fauna particular de moscas. A hipótese de distúrbio estaria relacionada ao processo de antropização, que neste caso pareceria ter efeitos na diminuição de todos os atributos de diversidade, ou seja, na riqueza, abundancia e dominância, e favoreceria a ocorrência de espécies sinantrópicas. Finalmente, no gradiente altitudinal, os ambientes de altura intermediaria (1000-2000m), sobretudo nos Andes, foram os mais diversos. Além disso, nessa mesma faixa foi encontrado o maior número de espécies da região, as quais foram classificadas como espécies de montanha (Figura 2, capítulo 4). Vários estudos têm explicado essa tendência baseados principalmente na alta disponibilidade de água, alta produção primaria e ótimas condições do solo nesses ecossistemas (Rahbek, 1995), todas estas características observadas nos ecossistemas de altitude intermediaria avaliados na região norte da América do Sul. Por outro lado, a hipótese histórica e evolutiva inclui processos mais complexos que devem ser estudados no contexto da biogeografia. Assim, o conhecimento da evolução geológica da região aliado ao cálculo ou estimativa de divergência das espécies e a resolução filogenética dos táxons possibilitaram uma clara visão do cenário evolutivo dos califorídeos nesta complexa região Neotropical. A evidente sensibilidade dos califorídeos aos ambientes antropogênicos, seu número accessível de espécies e sua taxonomia relativamente estável faz deste um grupo ideal para ser utilizado como indicador de ambientes antropizádos na região norte da América do Sul.

O conhecimento taxonômico abrangente é necessário para separar com precisão as espécies de vários grupos de Califorideos. Nós fornecemos a primeira biblioteca de referência do mini-código de barras para quase 60% das espécies de Calliphoridae neotropicais. Este marcador de relativamente fácil de recuperar não só demonstrou uma facil a associação de espécimes, mas também contribui para o rápido avanço do conhecimento dos taxa, elucidando os problemas taxonomicos atuais. Animamos estudos adicionais para avaliar sua confiabilidade em estádios larvais, tecidos remanentes e espécimes malconservados ou em casos de interesse forense. Mais estudos morfológicos adicionais tradicionais bem detalhados incluindo morfologia fina são necessários para resolver a falta do conhecimento atual.

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